



SURGICAL EMERGENCIES IN  
CHILDREN



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LONDON  
BAILLIÈRE, TINDALL AND COX  
7 & 8 HENRIETTA STREET COVENT GARDEN W.C. 2

1936



PRINTED IN GREAT BRITAIN

## PREFACE

My grateful thanks are due to the Committee of Management of the Evelina Hospital for Sick Children and to my medical and surgical colleagues there for their permission to make free use of the clinical material upon which this little book is based. Dr Vernon Hall and Mr Geoffrey H Bateman F R C S have written the chapters on anaesthesia and the ear nose and throat respectively and I am indebted to Mr H L C Wood M S F R C S and to my late House Surgeon Mr E J Smith F R C S for their help in the preparation of the section dealing with fractures and to Miss Irene Swain for the secretarial work. The drawings are all original and are with one exception from the accomplished pen of Miss Mary Barclay-Smith.

As far as possible the subjects discussed are limited strictly to emergency conditions and I have resisted the very strong temptation to include congenital stenosis of the pylorus although Dr Hall has referred to this condition in his chapter on anaesthesia.

H C L

LONDON

*December 2 1935*



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# SURGICAL EMERGENCIES IN CHILDREN

## CHAPTER I GENERAL PRINCIPLES

### Pre-Operative Preparation

PRE-OPERATIVE preparation in emergency work is necessarily limited by consideration of time for in most cases the sooner operation is performed the better. Paradoxically it is in those cases in which operation has been already overlong delayed that pre-operative administration of saline is most strongly indicated and in which operative measures may be still further delayed for this to be done. Thus for example in the early stages of acute intussusception the patient is still well and operation should not be delayed whereas in those cases of intussusception which reach the surgeon late in the history of the disease it is often wise to delay operation for a few hours longer in order to attempt to improve the condition by the infusion of saline and glucose. In cases where there has been much sickness a gastric lavage should be performed before the operation is undertaken. In the sick child this is usually a very simple matter the patient submitting to it without complaint.

The skin should be prepared for operation by washing with warm water and soap. A hard nail brush should not be used for this purpose on the skin of the abdomen. Careful drying helped with acetone or surgical spirit is followed by the

application of iodine. When this is used in abdominal operations, it is important to cover the edges of the incision with skin veils.

### **Local Anæsthesia**

General anæsthesia (Chapter II) is to be preferred to local anæsthesia for the great majority of emergency operations. The strongest indication for the use of local anæsthesia is the absence of a skilled anæsthetist adequately equipped with the necessary apparatus. The second indication is the presence of a toxæmia of such intensity that inhalation anæsthesia is best avoided. Novocaine is probably the safest local anæsthetic and is very efficient. A dilute solution such as 0.5 per cent should be used, and success depends upon using plenty of it in a fresh solution. Adrenalin chloride 1/10,000 should be added to the novocaine in the proportion of five minims of adrenalin to one ounce of novocaine. No special apparatus is necessary, although it is an advantage to have a Labat type of needle and syringe. The essential step in giving the anæsthetic is the raising of a cutaneous wheal. This is first done at one spot, the needle being entered into but not under the skin and a small circular wheal raised. Through this the subcutaneous tissue is widely infiltrated. Finally, a linear wheal is raised corresponding with the intended line of the incision (Fig. 1).

### **The Operation**

The two essentials are speed and gentleness in handling. Of the two there can be no question but that the latter is by far the more important and should not be sacrificed for the sake of speed alone. Shock is produced in abdominal surgery not so much by the time taken, although naturally this must be a factor, as in the degree of trauma to the intestines and the mesentery. One should always try to prevent coils of intestine from coming outside the abdominal wound. Such

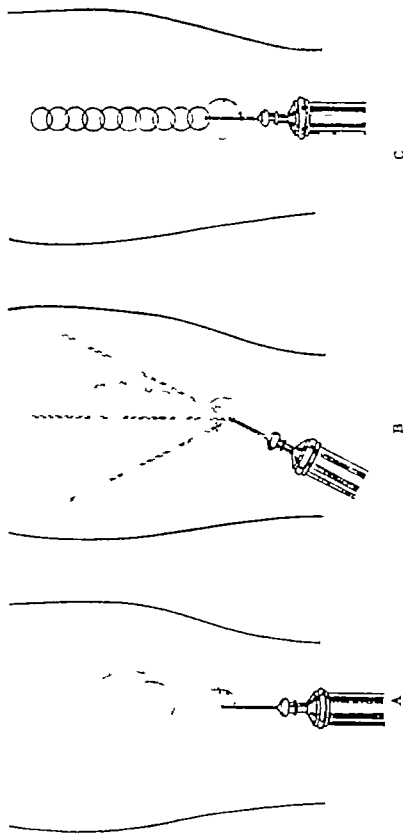


FIG 1

A A small intradermic injection is first given B Through the intradermic injection the surrounding tissues are infiltrated C. A linear intradermic injection is given following the line of incision intended



an accident will happen occasionally—in reducing an intussusception, for example—but it should be anticipated and prevented, for the sum total of the operative shock is increased enormously should this occur. In operations where a considerable time is to be taken in their execution and where toxæmia is present, such as in acute osteomyelitis, it is our custom to give continuous subcutaneous saline throughout the operation.

### **Administration of Fluids**

In cases where the patient is unable to take an adequate quantity of fluid by mouth it may be administered by proctocolysis, by subcutaneous injection or by intravenous infusion. The fluid used in each case is saline, made up of one drachm of sodium chloride to one pint of water. To this may be added glucose, which should not exceed  $2\frac{1}{2}$  per cent when the fluid is given hypodermically or intravenously.

Administration of saline per rectum is not practicable in children under the age of three or four years. In older children it is an excellent method if it is required to give fluid slowly over a long period, such as during the day or two following operation when the patient is unable to take an adequate quantity by mouth. In infants and in cases where the administration of fluid is a more urgent need the method of subcutaneous injection should be used. In older children this may be given by the continuous method as in adults, but in infants and in the newborn it is best given by injecting the saline slowly through a syringe into the subcutaneous tissue of the antero-internal aspect of the axilla. In this way two or three ounces may be given at intervals of three to four hours in the smallest infant. It is an advantage to include  $2\frac{1}{2}$  per cent glucose in the saline solution, and the whole must, of course, be sterilised by boiling.

The administration of saline by the intravenous route is of the greatest value in cases where it is required to give

a considerable quantity of fluid rapidly. The fluid may be given in set quantities at intervals or by the continuous drip method in which case the type of needle devised by Bateman will be found of the greatest use. The needle consists of four parts (Fig. 2) a sharp trocar (A) a blunt trocar (D) and two canulas (B and C). The needle may be introduced into a vein by puncture of the skin only but where it is difficult to make a vein stand out so that it can be plainly seen it is better to make a small incision over

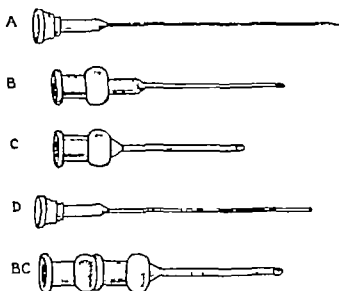


FIG. 2.—BATEMAN'S NEEDLE.

For description see text

it using a local anæsthetic of 0.5 per cent novocaine. The trocar (A) is placed in the canula (C) the vein is entered and the trocar withdrawn. The canula (B) which is attached to the rubber tubing leading from the receiver containing the fluid to be administered is now placed in (C) and the infusion commenced the drip method being used. The canula (C) is held in position by means of strapping. When it is required to discontinue temporarily the administration of the saline the canula (B) is withdrawn and the blunt

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trocár inserted This, in turn, is replaced by the canula (B) when it is required to give a further quantity of fluid.

In the case of the newborn and infants the best means of administering intravenous saline is via the longitudinal sinus The needle is passed into the sinus obliquely from before backwards at a point corresponding with the centre of the anterior fontanel The head must be kept still during the infusion by means of two sandbags placed one on either side and fitting snugly against the side of the head and neck This method is not recommended for children in whom the fontanel has closed, although in cases in which the fontanel has only recently closed Fèvre\* makes use of it by piercing the thin lamina of bone with a strong needle Two and a half per cent glucose may be added to the solution of normal saline

### **Blood Transfusion**

The many technical difficulties which have so limited the use of blood transfusions in the past have now been largely overcome by new methods, and blood transfusion is being used with greatly increasing frequency in the treatment of surgical emergencies in children

Its chief merit lies in restoring the depleted volume of blood in cases of hæmorrhage, after the bleeding has been controlled There is little doubt, however, that in addition the administration of blood actually produces a hæmostatic effect This is shown more clearly in transfusions given for hæmorrhage from a peptic ulcer in adults, but use may be made of it in the surgery of childhood in secondary hæmorrhage associated with sepsis Further, in the spontaneous hæmorrhage associated with hæmophilia this hæmostatic action is of considerable value. A final indication for blood transfusion lies in septicæmic conditions,

\* Fèvre, M, "Chirurgie Infantile d'Urgence," Paris, 1933

in which cases it probably acts quantitatively by increasing the amount of fixation antibodies

Although the blood of the donor selected and that of the recipient may belong to compatible blood groups it has been shown that the only safe method of selection is to test the blood of the donor directly against that of the recipient before the transfusion is given. The simplest method\* of doing this is to take 1 c.c. of blood from the recipient and to allow it to clot. To a drop of the resulting serum is added a small drop of blood from the donor suspended in 1.5 per cent citrate solution. The mixture is examined for agglutination and if this is negative the blood of the donor may safely be used. It is hardly necessary to add that the intended donor must be in good health and free from any syphilitic or tuberculous taint.

The citrate method of administration is probably the method of choice. All that is needed is a graduated flask of 1½ pints capacity and the necessary needles, canula and rubber tubing connection. One hundred c.c. of 2.5 per cent solution of sodium citrate is placed in the flask and kept at a temperature of 100° F. The necessary quantity of blood is withdrawn from the donor by means of a needle and canula and thoroughly mixed with the citrate solution. The whole is then introduced as soon as possible into a suitable vein such as the internal saphenous. The blood should be infused very slowly, not more than 100 c.c. being allowed to enter the vein every eight minutes. The quantity of blood transfused will depend upon the age of the patient and the condition for which it is being used. In severe primary hæmorrhage in the older child a large transfusion of some 400 to 500 c.c. will be needed. In cases in which transfusion is being used for septicæmia it should not exceed 150 to 200 c.c.

\* Lee R. *B.M.J.* 1917 ii p 684

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### **The Treatment of Shock**

So little is known of the pathological processes underlying the condition of shock, that it is impossible to rationalise regarding its treatment. A constant feature is a grave cardio-vascular disturbance resulting in an extremely low blood pressure. The low blood pressure is due not to the depletion of the total volume of blood but to its withdrawal from the systemic circulation. It is therefore a matter for debate whether saline infusion or blood transfusion is of value in its treatment, for it appears that as soon as either saline or blood is given into the systemic circulation it is withdrawn—probably into either the capillary vessels or the splanchnic circulation—so that its value as a restorative is lost. Judged solely from the standpoint of clinical experience, however, the administration of fluids is unquestionably of value. Blood transfusion itself does not appear to have any advantage over the administration of saline. It must be urged, however, that the administration of fluids subcutaneously or intravenously does not replace their administration by mouth, which is the ideal method, but it should be regarded as supplementary except when the patient is unconscious or for some other reason unable to drink.

Apart from the giving of fluids, the essential features of the treatment of shock are absolute rest and warmth. It goes without saying that if it is feasible the cause of shock must be dealt with or, if still acting, it must be removed. Thus, for example, fractures of the femur should be immobilised immediately, for movement at the point of fracture will further add to the shock already caused by the accident.

It is frequently a matter for comment how well a newborn infant is able to withstand the shock associated with operation, as the operation performed in the patient suffering from exomphalos (p. 194) exemplifies, and one should not, therefore, refuse to perform an urgent operation on the new-

born child on the grounds that the shock would be too great

Rest should be assured in the older child by injections of morphin but care must be taken in this connection not to administer it when the shock is associated with abdominal injury for fear that it should mask symptoms of a visceral lesion. In the young child morphia must be avoided. The patient should be kept warm by wrapping his legs and arms in cotton wool and by placing in the cot a cage from which is suspended an electric light. In the older child it is probably helpful to raise the foot of the cot. If the child is conscious stimulating drinks should be given by mouth. Injections of strychnine and coramine should not be used save in exceptional circumstances such as sudden collapse during or after operation.

### **Acidosis (Ketosis)**

A mild degree of acidosis is common in all children when first admitted into hospital whether acutely ill or not. It is constant in the emergency case though it naturally will vary greatly in degree according to the cause of the illness. In severe cases operation should be delayed until subcutaneous saline and glucose have been administered. The minimum amount of ether must be given during the operation and subcutaneous glucose saline given again when the operation is completed. In milder cases in which only a trace of acetone appears in the urine it is sufficient to give saline and glucose per rectum after the operation.



## CHAPTER II

### GENERAL ANÆSTHESIA

(BY DR VERNON HALL)

THE question of anæsthesia in surgical emergencies will be discussed under three headings premedication, administration of gas and oxygen, and the choice of anæsthetic in specific cases

#### Premedication

1. **Atropine** is an essential preliminary to any anæsthetic, but particularly is this the case in children, who show a marked tendency to hypersecretion. If the dose of atropine is insufficient, as is frequently the case, the amount of mucus secreted may be sufficiently great to render the course of the anæsthetic extremely difficult. Children tolerate atropine remarkably well, and the doses recommended are.

Below 3 months . . . . .	gr 1/200
From 3 months to 3 years . . . . .	„ 1/150
Above 3 years . . . . .	„ 1/100

The atropine must be given *at least* a half an hour before operation

2 **Basal Hypnotics.**—For a number of years drugs have been given preoperatively to allay the fear of the anæsthetic. Of these morphia, scopolamine and omnopon are still in frequent use for this purpose, and these three drugs can be used separately or in combination as a premedication for children. There is little, however, to recommend them, their action is erratic and generally less well marked than in adults, and they give rise to a depression of the respiratory

centre which is sufficient to make the subsequent administration of the anæsthetic very difficult if not actually dangerous. Should it be considered advisable to use them, the dose for children can be calculated in the usual formula

$$\text{Pharmacopœial dose} \times \frac{\text{age}}{\text{age} + 12}$$

Should a combination of two be used the dose of each is of course reduced

3 **Nembutal** is the only other hypnotic given by mouth which is worthy of mention. It cannot be considered a very satisfactory form of premedication owing to its erratic action it being impossible to foretell how much effect it will have and hence very difficult to calculate dosage which may however be worked out on the formula already given the adult dose being gr 3. The advantages of nembutal however lie in the ease of administration and its portability so that it may be used in cases in which other basal anæsthetics are difficult to obtain or when pathological conditions of the rectum and colon preclude the use of anæsthetics administered by this route. Two points to be noted are that the capsule should be pricked to aid rapid absorption and that it should be given three-quarters of an hour before operation.

4 **Paraldehyde** given per rectum undoubtedly takes first place among the basal anæsthetics for children. It is essentially safe and when skilfully administered gives a sound sleep to which any other form of anæsthesia may be added without the child returning to consciousness. The further administration may give rise to some crying or movement but this is quite involuntary and transient and the subsequent course of the anæsthesia is very smooth the general reactions and respirations of the patient being entirely unaffected by the paraldehyde. Moreover the amount of anæsthetic required is considerably diminished

The success of paraldehyde, however, depends upon its method of administration. The solution must be given very slowly, taking about five minutes over each ounce, and the child must be encouraged to retain it. A nurse capable of handling children tactfully seldom fails, whereas any effort to hurry or any loss of patience will probably lead to the return of most of the solution.

The suitable dosage of paraldehyde is one drachm per stone of body weight made up to 10 per cent solution with saline, and given at body temperature, at least three-quarters of an hour before operation. The offensive smell is by no means so great a handicap as is usually supposed, for it is rare to hear a child complain either of its smell or taste.

5 **Avertin** cannot be considered as safe as paraldehyde, inasmuch as it does lead to some respiratory depression and fall in blood pressure, and undoubtedly it has a slight toxic effect on both liver and kidneys. It has the advantage of being very reliable in its action and of giving a deeper anaesthesia than paraldehyde, so that it is to be preferred in cases in which a successful premedication is essential or in which inhalation anaesthesia is to be cut down to the absolute minimum, as, for example, in a child with a tuberculosis of the lung, requiring an emergency operation. The dosage can be worked out on the same scale as for adults: 0.1 gm per kilo body weight made up to a 2½ per cent solution with distilled water. This solution is heated to 100° F and tested with a few drops of congo red before giving; a blue colour indicates the presence of free hydrobromic acid, and in this case the solution should be discarded. The solution is run into the rectum through a soft-rubber catheter inserted about 3 inches, and about fifteen to twenty minutes should be taken over the injection. Should the child become unconscious before the whole solution has been used, the injection should be suspended.

and not continued if the child shows no sign of returning consciousness. It is advisable to leave the catheter in place clamped with a pair of Spencer Wells forceps as withdrawal may give rise to the return of the solution.

It is frequently stated that avertin causes loss of the cough reflex and hence should be avoided in nose and throat operations. With the standard dose suggested this is very seldom the case as the reflex remains brisk both pre and post-operatively hence there is no danger of bleeding passing unnoticed always provided that sedative drugs are not given for some time after the end of the operation and provided that really efficient post-operative nursing is guaranteed.

The practice of combining avertin with morphia has been advocated by some but this method cannot be recommended as it is liable to lead to such profound respiratory depression as to greatly increase the risk should further anæsthesia be required.

Again the combination of avertin morphia and local anæsthesia has been extensively tried out at some hospitals but although it may be successful in a few skilled hands the results are usually so unreliable that it should not be used for ordinary purposes in the case of children.

#### CONTRA INDICATION TO THE USE OF BASAL ANÆSTHETICS

**Age.**—In infants below the age of two years the margin of safety in anæsthesia is so small that anything in the way of standard dosage of hypnotics cannot be considered safe and moreover the respiratory depression which follows the use of this group of drugs is most undesirable in the very young. Paraldehyde is the only one of the group which can be considered really safe below this age. It is of course very difficult to persuade a child of this age to retain the solution although it is undoubtedly worth making the attempt.

**Shock.**—All basal anæsthetics tend to lower blood pressure, the tendency is only slight, but sufficient to make the contra-indicated in cases already suffering from a marked degree of shock.

There is little doubt that in the gravely shocked child, whether from pathological conditions or from accident, ether still remains the safest anæsthetic. The rise in blood pressure caused by ether will often enable a surgical procedure to be carried through safely. The subsequent fall of blood pressure to its pre-anæsthetic level at the completion of the operation is much easier to combat than any fall which may take place during the conduct of the operation.

**Respiratory Embarrassment.**—The child that shows a dyspnoea or cyanosis before operation, as may occur, for example, with empyema, needs treating with extreme care, and the increased risk which may be entailed by giving basal anæsthetic outweighs the advantage gained.

**Contra-indication to Rectal Administration.**—For operations in the region of the rectum and anus, avertin and paraldehyde are contra-indicated, nor should they be used in a child which has any disease of the colon or rectum, such, for example, as a colitis, however mild the condition may be.

**Pathological Conditions.**—The presence of nephritis or any suspicion of poor liver function are contra-indications to the use of avertin or the barbiturates, although paraldehyde may be used with safety in such cases.

### Gas and Oxygen Anæsthesia

There is no doubt that the anæsthetic of choice for children whenever the operative procedure allows, is gas and oxygen. Unfortunately the administration is far from simple, children are apt to become cyanosed very easily, and it is frequently a difficult problem to find the exact percentage of oxygen necessary to keep the patient a reasonably good colour and

at the same time to produce anything approaching surgical anæsthesia. Gas and oxygen has the reputation of being a completely safe anæsthetic but it must be emphasised that this is quite erroneous. Unskilful administration leads to cyanosis and the effect of prolonged cyanosis is very harmful to a sick child particularly in cases in whom the myocardium is affected by a general toxic condition. In all cases where gas and oxygen is being used it is much better to add a small amount of ether rather than to keep

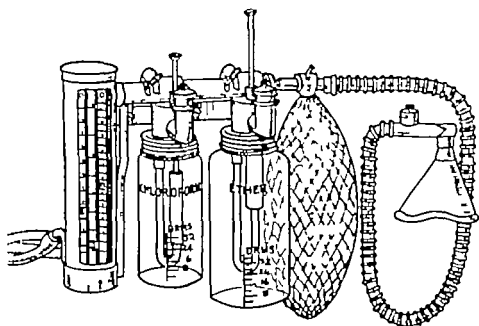


FIG 3—THE COVETER BOYLE GAS AND OXYGEN APPARATUS

the child at all cyanosed. A slight trace of ether vapour added early in anæsthesia may enable the case to be carried on under pure gas and oxygen for a considerable time adding extremely little to the after effects and nothing at all to the immediate risk of the operation. Particularly is this the case when dealing with a very ill child. Ether is an excellent stimulant and a patient with a low blood pressure resulting say from shock or hæmorrhage usually derives much benefit from its administration in small quantities (Fig 3).

Many types of gas and oxygen machine are in use, but good results can be obtained with any one of them provided the anæsthetist is expert in using the particular type at his disposal. Whichever machine is selected the following points should be borne in mind.

1 The reservoir bag should be small in capacity and of thin rubber, as close to the patient's face as possible, or

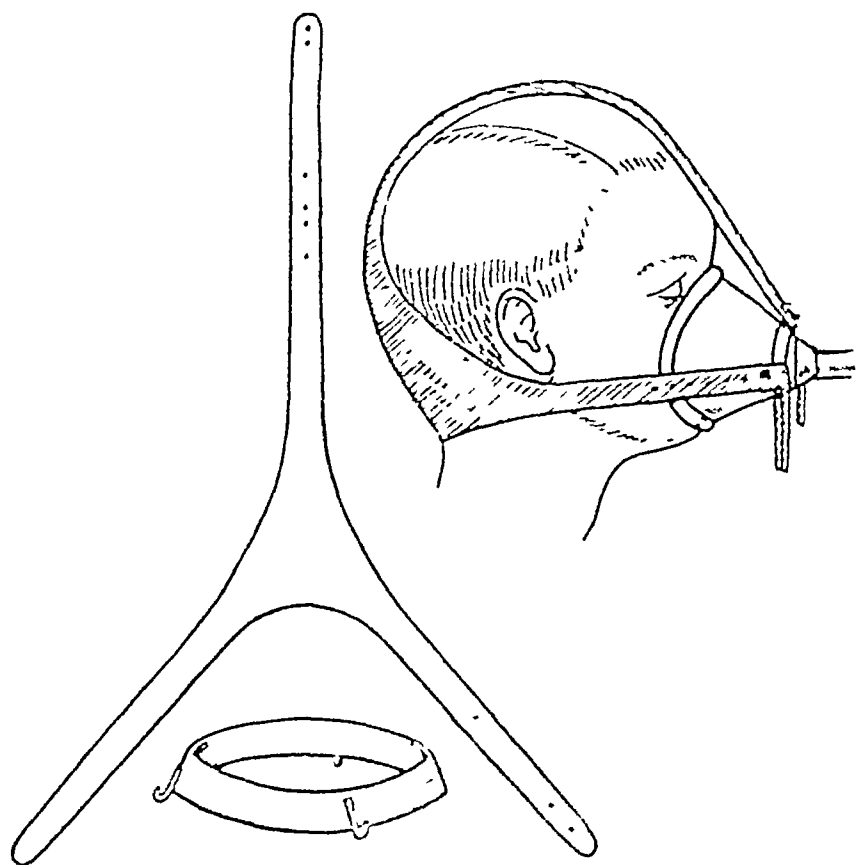


FIG. 4 —THE CLAUSEN HEADSTRAP, SHOWING APPLICATION

connected to the mask by means of a wide bore tube, and an expiratory valve is an essential fitting. These precautions allow for the rapid alteration of the gas and oxygen mixture so necessary in infants, and prevent the piling up of too large a percentage of carbon dioxide.

2 It is essential that the machine should be fitted with delicate fine adjustment valves and a sensitive and reliable

flowmeter The percentage of oxygen required is so finely balanced in some cases that many of the old type of valve are completely useless for accurate work It is also important of course that the dosage of ether if required should be capable of being finely adjusted as is possible with most modern gas and oxygen machines

3 Only very slight positive pressure should be used in children each inspiration should make the reservoir bag slack—greater pressure than this is of very doubtful advantage and certainly not without danger

4 Any effort at supersaturation is strongly contra indicated in children

5 A Clausen's headstrap (Fig 4) not only saves the anæsthetist from a great deal of trouble in holding the mask in position but is very much more efficient in providing that gas tight joint between the mask and the face so important in giving gas and oxygen

6 The mask with an inflatable rim is much to be preferred to the type with a Sorbo rubber rim the latter being much too hard and unyielding

It is seldom necessary to use any form of airway (Hewitt's etc) and these should be avoided with gas and oxygen if possible as they tend to produce coughing and retching with a light anæsthesia

### Choice of Anæsthetic in Specific Cases

**Operations on the Abdomen.**—Here the greatest difficulty lies in obtaining sufficient muscular relaxation to enable the surgeon to work as quickly and easily as possible without giving unnecessarily large quantities of chloroform or ether For all abdominal cases except congenital pyloric stenosis the anæsthesia of choice is gas and oxygen with the addition of sufficient ether just to produce the necessary relaxation About  $\frac{1}{4}$  to 2 oz ether should suffice for most of



these cases, and the increased respiratory excursion produced by this method, as compared with the open administration of ether, by giving rise to greater expansion of the lungs decreases any risk of chest complications so much as to outweigh the slight disadvantage suffered by the surgeon.

The question of congenital pyloric stenosis is a very difficult one, although the infant is very young and probably rather ill it is unlikely that gas and oxygen by itself will produce enough relaxation, and many surgeons prefer to use local anæsthetics for this type of operation, on the assumption that even a small quantity of ether is liable to produce a broncho-pneumonia.

There is no doubt that a fair percentage of cases in which a general anæsthetic is used get a broncho-pneumonia, but one also has to remember that when a local anæsthetic is used a number of cases get a local sepsis round the wound, which may be severe enough to influence the result of the case.

The opinion generally held with regard to Rammstedt's operation is that provided an experienced anæsthetist is available, the results of operations performed under gas and oxygen are very good, but that a local infiltration is to be preferred to an unskilfully administered general anæsthetic.

With reference to spinal anæsthetics in children, statistics show quite conclusively that the mortality rate in abdominal operations under spinal anæsthesia is much higher than for any other method, and hence spinals may be considered to be contra-indicated in surgery of children.

**Operations on the Throat.**—One of the most alarming forms of emergency from the anæsthetist's point of view is the case of hæmorrhage following tonsillectomy. The child is brought into the anæsthetic room considerably shocked from loss of blood and with not only its throat full of blood, but its stomach containing a large amount of

swallowed blood which is liable to be vomited during induction. Every effort should be made to have some form of suction apparatus ready for use before starting the anæsthetic. The child should be placed with a sandbag under the shoulders and in a slight Trendelenburg position before starting the induction for which ethyl chloride is undoubtedly the most satisfactory agent. Given in a dose of about three-quarters of the full dose for a fit child of the age it is quite safe and has the great advantage of rapidly producing sufficient anæsthesia to enable the throat to be sponged or sucked free from blood. Anæsthesia can then be carried on with ether given by means of a Boyle Davis gag or through an endo-tracheal catheter as desired.

At this stage a few remarks on ethyl chloride are not out of place. It is frequently considered to be both very dangerous and very unpleasant to the child. It is true that a number of deaths under ethyl chloride anæsthesia have occurred but it must be remembered that it is the anæsthetic most commonly used for induction of children and also that it is administered by relatively unskilled people more frequently than any other anæsthetic. Its greatest danger lies in the fact that it is a rapid and powerful anæsthetic and hence it should always be used in small doses the practice of giving repeated full doses of ethyl chloride in order to complete an operation requiring five or more minutes of anæsthesia cannot be too strongly condemned.

Again ethyl chloride is considered very liable to produce laryngeal spasm. This is undoubtedly true but in a large number of cases the spasm is due to faulty technique on the part of the anæsthetist. Any anæsthetic given in sudden large doses is liable to lead to spasm and if ethyl chloride is inhaled slowly very little trouble should arise. Deaths which have been reported as due to a generalised spasm of respiratory muscles are almost certainly due to an overdose of ethyl chloride.

**Operations on the Head and Ear.**—For operations upon the mastoid, cerebral abscess, and fractures of the skull the most satisfactory anæsthetic is gas and oxygen, preferably given through a Magill wide bore endo-tracheal catheter (Fig. 4B), the usual mask method of administration produces too many technical difficulties, and tends to result in a

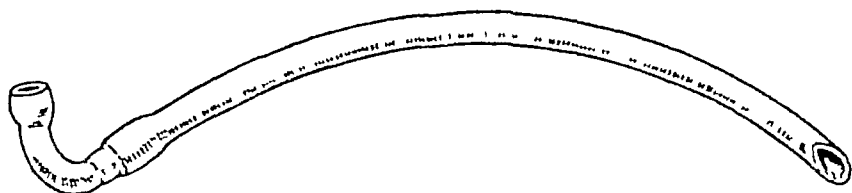


FIG 4B —A MAGILL ENDO-TRACHEAL CATHETER

continual struggle between the surgeon and anæsthetist for the possession of the head. Should intra-tracheal apparatus not be available, the second best form of anæsthesia is gas, oxygen, and ether blown under a Schimmelbusch mask when the head is largely covered with towels, the light anæsthesia that is necessary can be produced with very little ether and the results are excellent.

## CHAPTER III

### PYOGENIC INFECTIONS

#### Cellulitis

INFECTION of the cellular tissue in children differs little either in pathology or treatment from that in adults. It is characterised by a brawny swelling of the subcutaneous tissue and a high temperature. There is frequently difficulty in deciding whether or not a true septicæmia is present in severe cellulitis, although in every case of heavy infection there must be organisms circulating in the blood stream and a blood culture in the early stages of the disease will thus be positive. In most cases of cellulitis surgical intervention should be postponed until there is some evidence that the infection has been localised to produce an abscess; the practice of free incisions down to the subcutaneous tissue before localisation has occurred is to be condemned. The exception to this statement is in cases where the œdema accompanying the cellulitis is under considerable tension and giving rise to pain on this account. Thus for example a linear incision down to the deep fascia in cellulitis affecting the palm of the hand may give considerable relief. The local treatment for cellulitis is that of counter irritation and the best means of obtaining this is by large, frequently changed hot fomentations. If any operation has been performed so that an open wound is present fomentations should be preceded by immersion of the limb in an arm-bath.

**Acute Lymphangitis : Acute Lymphadenitis**

The treatment of acute lymphangitis is similar to that of acute cellulitis. The method of making circular incisions through the subcutaneous tissue of a limb in an effort to interrupt the lymphatics and thus prevent absorption by them is based upon wrong principles and should therefore not be attempted. Similarly, the operation of lymphaticostomy in peritonitis is of no value. Local application of counter-irritants and the general and specific methods discussed under the treatment of cellulitis should be employed.

Swelling of the lymphatic glands is a favourable sign when associated with acute infection of the area which they drain. Frequently the acute inflammation in the glands resolves spontaneously when the original focus subsides. In cases where frank suppuration is present the glands should be opened and drained. The method of Hilton should be employed in these cases, especially when dealing with the glands of the axilla or in the submaxillary triangle. A small incision is made at the point of maximum swelling and a pair of sinus forceps is then forced into the abscess cavity and the blades opened. A small drainage tube must be inserted into the cavity, when the latter is a dependent one, such as in the two regions mentioned, the drainage tube should be held in position by means of a stitch passing through one lip of the wound. A copious dressing of 1/40 carbolic or 1/2,000 perchloride of mercury should be used. Once the abscess has been opened it is inadvisable to continue hot fomentations.

**Toxæmia and Septicæmia**

The high temperature in acute pyogenic infection may be due to a pure toxæmia or to a septicæmia, and it is quite impossible to distinguish between them on clinical examination. A blood culture will be positive in the early stages

of the disease even if the condition is not a true septicaemia but a bacteraemia. For the purposes of treatment however it is probably wise to regard all such cases as septicæmic. The most common organisms are of course the *Streptococcus* the *Staphylococcus aureus* and somewhat more rarely in surgical conditions the *Pneumococcus*. Infection by the first two are usually more virulent than that by the pneumococcus. Staphylococcal infection in its severest form is perhaps the most fatal. Apart from the local treatment of the source of the infection e.g. cellulitis or osteomyelitis the question of serum therapy arises. In staphylococcal cases this is of no value. In streptococcal cases serum therapy is certainly worthy of trial for on occasion a brilliant result is obtained. In order for this to occur the serum must be specific for the infecting organism. In the case of the child of say ten years an intramuscular dose of 20 c.c. of anti scarlet fever streptococcal serum is given. If no improvement is shown judged by a fall in the temperature 20 c.c. of the polyvalent anti streptococcal serum is given on the following day. If there is no indication of a favourable reaction then the serum therapy is discarded. Should a favourable reaction be obtained with either serum then a dose of 50 c.c. should be given followed by daily inoculation of a similar amount until the fever has abated.

Intravenous antiseptics such as mercurochrome are in my experience of no value. The production of a fixation abscess by injecting an irritant such as turpentine into the abdominal wall or elsewhere is advocated but I have had no experience of it and hesitate to use it in children. Immuno-transfusions are somewhat disappointing but a small blood transfusion of 50 to 100 c.c. is definitely of value and probably acts quantitatively by increasing the amount of fixation antibodies. I have little faith in any of the symmetrical urea compounds such as S U P but advocate

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the administration by mouth of concentrated vitamin A in the form of Radiostol tablets.

Unless the specific serum can be obtained, in which case a cure will result, the most important feature of the treatment in septicæmia and all severe toxæmic conditions lies in the nursing of the case. Rest and the liberal administration of fluids are the essentials. In a child of ten years of age one should aim at the administration of 100 ounces of fluid per day. If this amount be not taken by mouth, then it should be made up by continuous rectal or subcutaneous saline.

### **TETANUS**

It is necessary to stress the importance of the prophylactic dose of anti-tetanic serum in all cases of open wounds due to injury. In cases of established tetanus the treatment is largely serological and the success of the treatment depends very greatly upon the amount of serum used, and one should not hesitate to give from 50,000 to 100,000 units during the first few days of the treatment in acute cases. The serum should be introduced into the subarachnoid space by means of a lumbar puncture and 10,000 units of serum should be given by this means each day after the withdrawal of cerebrospinal fluid equal in volume to the anti-toxin injected. The treatment must be begun at the earliest possible moment. The patient is nursed in a darkened room and all noise or light avoided. In the older child morphia may be given and in the younger, chloral hydrate per rectum. If the tetanic spasms are frequent and severe, it may be necessary to administer chloroform continuously for an hour or more. Little benefit is to be derived by any radical treatment of the wound itself other than that conforming to ordinary surgical principle, and no attempt at excision of this should be made unless the wound is a small punctured one.

## BURNS

The treatment of burns in children does not differ in any particular from that in adults. The attention is directed to the treatment of the associated shock, the local treatment of the burn and the prevention of toxæmia and finally to the prevention of contractures. In the young child burns of the face and body are chiefly met with and are due in the majority of cases to scalds from boiling water but occasionally one meets with burns resulting from the clothing catching fire. Of the degrees of burns originally described by Volkmann the second and third degrees are the ones which most frequently call for treatment.

**Shock.**—The younger the child the greater the shock sustained. The degree of shock is otherwise dependent upon the surface area affected and is particularly severe in burns of the chest wall and abdominal wall. In the very young infant morphia is contra-indicated but in the older child there should be no hesitation in using it the dose being in strict accordance with the formula

$$\text{pharmacopœial dose} \times \frac{\text{age}}{\text{age} + 12}$$

If the child is conscious and it is practicable fluids preferably hot should be given in liberal quantities by mouth in the younger child and in the unconscious state fluid is best given by the subcutaneous method but there should be no hesitation in giving intravenous fluid by means of a Bateman's needle if the shock is severe. The child must be kept warm and the burnt areas well protected. Local treatment of the burns must of necessity be postponed until the child shows evidence of recovery from the shock.

**Local Treatment of the Burns and Prevention of Toxæmia.**—In the third degree of burns which is that most frequently met the sensitive nerve terminals are laid bare and

hence exposure of the part predisposes to shock. In an extensive area of burning an additional factor is the absorption from the large raw area of toxic material resulting mainly from the partially destroyed tissue, and at a later date from sepsis. Thus it is clear that the local application should act as a protective, and at the same time should prevent absorption, for in those cases which survive the initial shock death is almost invariably due to toxæmia which terminates in pneumonia or nephritis, or both. Preparations of wax have long been used in order to give a protective coating to the burnt area, but such preparations have no controlling effect upon the toxæmia. Picric acid has a certain degree of usefulness in causing a coagulum of the toxic exudate, and at the same time prevents sepsis by its antiseptic properties, but the coagulum it produces is a very thin one and does not offer a very adequate protective coating. Moreover, picric acid is in itself dangerous, and fatal results of picric acid poisoning have occurred from its too liberal use over a wide area. The so-called physiological method of treatment of burns has undoubted advantages. The essence of this method is to keep the part immersed in a warm bath of normal saline. The part is thus adequately protected and, in addition, toxic exudates are washed away. The practical disadvantages of the method are obvious. It cannot be used for burns of the trunk and even in burns of the extremities it is almost impossible to apply in the case of the very young child.

There is little doubt that the most effective treatment of burns which has yet been devised is that of tannic acid. In tannic acid we have a powerful coagulant. It produces a thick coagulum which adequately protects the part, and which is itself composed of that toxic material which, by its absorption, would give rise to toxæmia. Thus tannic acid adequately fulfils two necessities—those of protection and of preventing toxæmia. It has the disadvantage, however,

that it will prevent the free discharge of septic material and pus may collect under the thick coagulum which is formed. This very undesirable state of affairs may be prevented if the wound is adequately prepared before the tannic acid is used and the practice of applying tannic acid to a wound before it has been prepared cannot be too strongly condemned. In small superficial burns of the hand a compress of 2 per cent tannic acid and 1/2 000 perchloride of mercury as suggested by Mitchiner\* may be applied with satisfactory results but when there is a large and extensive area the tannic acid is best applied by means of a spray (Fig 5). The procedure is as follows

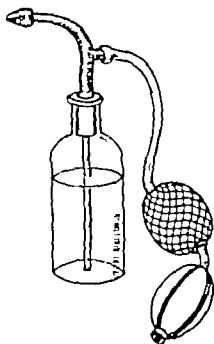


FIG 5—A SUITABLE FORM OF SPRAY FOR THE APPLICATION OF TANNIC ACID

When the child shows evidence of recovery from the initial shock an anæsthetic is given. This should be gas and oxygen. Clothing is removed completely and the wounds are carefully cleaned. All dirt is removed and all tags of skin are cut away and blisters are opened. The edges of the wound are carefully dried by means of spirit. Tannic acid 2½ per cent in water is then applied by means of an ordinary de Vilbiss spray. The tannic acid must be freshly prepared alternatively the colossal form obtainable in sealed ampoules may be used. The parts affected remain exposed to the air. In children especially in the young baby a tent is built over the cot and no bed-clothes are

\* Mitchiner P H *Lancet* 1933 i 233

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allowed to cover up the body. One or two electric lamps are placed inside the tent (Fig. 6). It will be necessary in the case of the young child to tie the feet and hands to the cot sides or to put on straight splints. If the arms or legs are burnt, then the splints are essential. They should be light and of minimum width. The application of tannic acid is continued every half-hour until the thick brown coagulum forms, and when this has been achieved no further

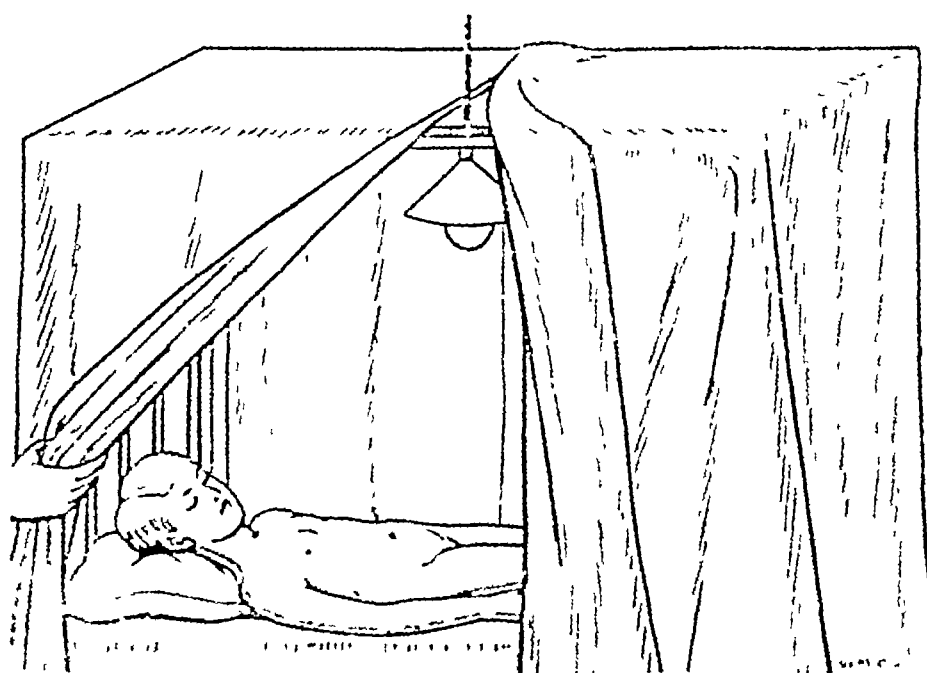


FIG. 6.—A TENT SUITABLE FOR USE IN THE TREATMENT OF BURNS BY TANNIC ACID

application is necessary. In burns of the face, the eyes must be carefully protected during the spraying. It is safer in actual practice in burns in this situation to apply the tannic acid by means of a pledget of wool. After four or five days there will probably be a little redness around the coagulum and small pockets of pus may appear. By this time the coagulum has done its work, and in such cases it may be softened by means of hot fomentations and allowed to peel



## CHAPTER IV

### FRACTURES

#### CLOSED FRACTURES OF THE LONG BONES

SEVERAL points of difference are to be observed in comparing fractures as a whole in children with those of adults, both as regards incidence and treatment. Fractures affecting the epiphyses of the long bones are naturally confined to the child, in whom many of the fractures *commonly met* with in adults, such as Colles' fracture, Pott's fracture and fracture of the neck of the femur, are practically unknown. Analysis of a series of figures shows that fractures of children, excluding compound fractures, occur in the following order of frequency

- The clavicle
- Both bones of the forearm
- Shaft of the tibia
- Lower end of the humerus
- Lower end of the radius
- Shaft of the femur
- Lower end of the tibia.

Other fractures are of comparatively rare occurrence. The greenstick fracture, of course, is entirely confined to children.

In dealing with fractures in childhood the task of the surgeon is made very much easier by the fact that restoration of function after splintage is obtained far more readily than is the case in adults. One of the constant difficulties in dealing with fractures in adults is in making the decision as to when the splint should be removed and movement of the joint begun, and each case demands a nice judgment. In

children however this difficulty does not arise to anything like the same extent. The child's powers of movement in the joint and of muscular action will recover without the need for a lengthy period of treatment in the massage department even when the splint has been kept on for a time which in the adult would necessitate prolonged physio-therapeutic treatment. The surgeon is not constantly stimulated by economic demands to reducing the period of splintage to a minimum for in children this aspect fortunately does not need to be considered. If there is in any case doubt as to whether or not splints can be removed one can safely give them the benefit of the doubt and retain them for a further period without prejudicing the return of function. Children have so remarkable an ability to spontaneous recovery of function after prolonged fixation that there is rarely any need for subsequent physical treatment. It suffices in the majority of cases to reduce the fracture and hold it by a fixation apparatus until it is adjudged that the bone has firmly united and then to allow the child to recover the function of the limb by its own unaided efforts.

Plaster is the ideal form of splintage for fractures of the extremities in children. It has many advantages over wooden splints particularly in the young child not least among these is that one is sure with plaster that the splint will not be disturbed in any way and will require no readjustment when once it is put into position. Exceptions to the use of plaster will be in the case of fractures at the lower end of the humerus and fractures of the shaft of the femur. In simple fractures treatment by the method of skeletal traction by means of pins placed through the bone should be avoided for the bones in childhood are not suited to such measures and reduction should be achieved by manipulation. In this respect the power of recovery of the child is so very much greater than in the adult that absolute anatomical perfection in the replacement of the fragments



of the bone, though clearly desirable, is not essential to obtaining an excellent result both as regards function and alignment. The surgeon may therefore allow himself a little more latitude than he is justified in taking with adults, and the younger the child the truer this is. In my opinion the unpadded plaster splint is not suited for children, and the plaster should be applied over a pad of wool or a snugly applied bandage of flannel, which has been well powdered beforehand. Such a splint is extremely efficient; it is comfortable, and all complications secondary to the splinting can be avoided.

There is no absolute rule to guide one with regard to the duration of fixation of fractures in children. It should be remembered that the bones in children unite very much more quickly than in adults, and secondly, as already stressed, no harm results from unnecessarily lengthy splintage. The following is an approximate guide.

Clavicle .	2-3 weeks
Lower end of humerus .	1 month
Forearm . . . . .	1 "
Tibia . .	2 months
Femur . . . . .	3 "

After these periods of splintage for fractures of the tibia and femur it will be safe, usually, to allow the young child to bear weight on the leg.

There are two complications of fractures in childhood which are seen far more frequently than in adults. They are myositis ossificans and Volkmann's ischæmic contracture. Both of these are most common after fractures at the lower end of the humerus. Happily, with the modern technique of treatment, the incidence of both is rare.

Non-union in closed fractures in childhood is of rare occurrence. Perhaps the two fractures most prone to this complication are fractures of both bones of the forearm and

fractures of the humerus Good apposition and adequate splintage are necessary to avoid this

**Predisposing Causes of Fractures.**—Bones appear to vary considerably in different children in their power to resist the torsions and strains of injury even when the child is in apparent good health Pathological conditions may be present however which produce definite weakness of the bones Such weakness may be due to softness of the bones associated with rickets although rickets as a predisposing cause of fracture has probably been exaggerated In this disease the bones bend readily but do not fracture completely through the cortex breaking on the convexity of the bend only (greenstick fracture) Congenital brittleness of the bones is a not uncommon disease It exists in two or three different forms all of which are grouped under the heading of osteogenesis imperfecta In this condition which is familial the child's bones break as a result of the most trivial injury It is not infrequent for children so affected to have literally dozens of fractures during their childhood a break in the femur being produced for example by getting out of bed or a break in the humerus by putting on a coat Perhaps the most remarkable feature of this disease is that although the bones break far more readily than in the normal they are able to join up just as quickly and the surgeon must therefore not regard the presence of osteogenesis imperfecta as a contra indication to the routine treatment of fractures with the exception of open operation Apart from osteomyelitis and tuberculous disease in which the disease is of far greater significance than the fracture the only local causes of spontaneous fracture in children are a cyst of the bone and, far more rarely a giant-celled tumour Opinions are somewhat divided as to whether open operation should be performed forthwith if an X ray shows the presence of a cyst at the site of the fracture A good result may be obtained in some cases by either method—that is to say by

ignoring the presence of the cyst altogether and treating the fracture as that of a normal bone, or by exploring the fracture and removing the cyst. If the cyst be a small one, callus resulting from the fracture will probably obliterate it (Fig 7, A and B). If, however, the cyst in the bone is a long one and the fracture only passes through it near one or other



FIG 7A

Fracture through the neck of the femur due to a solitary cyst of the bone in a boy aged two and a half years, treated without operation

end, then its spontaneous obliteration by callus is improbable, and operation should be undertaken. In cases of doubt it is well to be conservative. Should a giant-celled tumour be present, operation is, of course, imperative.

A great present-day advantage possessed by the medical profession is the facility with which patients may be X-rayed

after injury In all our large towns and in most of the smaller ones throughout the country X rays are available and the medical attendant is saved the anxiety of attempting to determine whether a fracture is present by the eliciting of physical signs alone A fortunate feature is that in



FIG 7n

The appearance three years later The fracture has united and the cyst has been completely obliterated

most cases high-class radiography by specialists in the subject is not essential for a break in the bone will show in the poorest film Indeed if the fracture amounts to so small a crack that an inferior X ray does not show it its importance as a fracture is probably not very great An X ray should

be taken as soon as possible in all doubtful cases, and the child thus spared the pain which clinical examination must necessarily cause

### FRACTURES OF THE UPPER LIMB

**The Clavicle.**—This is quite easily the commonest fracture of childhood, and is not infrequently of the greenstick variety. When the fracture is complete and overlap is present, absolute reduction cannot be achieved, and therefore there is little object in attempting it. To obtain the best position possible a form of retention must be used which will brace the shoulders back and keep the distal fragment raised by supporting the arm. There has been a revolt from the older method of achieving this by strapping, as described by Sayers, and the three handkerchief method and the method suggested by Hey Groves\* of placing a board behind both shoulders have been in vogue for some little time. These methods were substituted for that of Sayers on the ground that strapping made the skin of the child sore. We have, however, returned to the use of Sayers' method for all but greenstick fractures. It is far more efficient as a means of retention, and once put on it requires none of the constant supervision demanded by the three handkerchief method. It is true that the skin may become a little sore, but this disadvantage is outweighed by the general advantages of the method, and in any case the strapping does not need to be on for longer than fourteen days in an average case. Strapping must be of the non-stretching variety, and two strips about 2½ inches in width are necessary. A pad of well powdered cotton-wool is placed in the axilla. The first piece of strapping is placed commencing on the inner side of the upper arm near the axilla, and wound round the arm from behind forwards and within outwards, taken

\* Hey Groves, J. W. 'On Modern Methods of Treating Fractures,' Bristol, 1921.

across the back and round the chest wall terminating just across the mid line in front (Fig 8 A and c) The second piece is applied commencing from the scapula just below the fracture passing down behind the upper arm and then being brought round the point of the elbow over the forearm which is held close to the body over the back of the hand across the uninjured shoulder and terminating on the back of the scapula of that side (Fig 8 B and c) It is inadvisable to cut a hole in the plaster at the level of the point of the elbow as originally recommended by Sayers for the skin which bulges through becomes œdematous It is better to protect the point of the elbow from the plaster by a small piece of felt but in the young child this is not really necessary The strapping should be left on for a fortnight to sixteen days and can be soaked off in the bath and the child should wear a tightly fitting sling to support the arm for the next week An unsightly lump of callus may appear at the site of the fracture but the parents may be reassured as Hippocrates pointed out many hundreds of years ago that this unsightly lump will disappear completely in the course of time It is of interest to observe that the method Hippocrates used for the treatment of this injury is identical with that described by Sayers though of course the materials he used were different

**Fractures near the Upper Humeral Epiphysis.**—The so-called epiphyseal separation or slipped epiphysis is rarely a true designation of the peri-epiphyseal injury for the majority of these are fractures through the cancellous bone immediately subjacent to the epiphyseal cartilage. This area is perhaps the weakest part of the long bones in children despite the fact that it is frequently the broadest Its weakness may be explained largely by its texture the cortex being comparatively thin and also by its extreme vascularity It is the danger point in the bone not only as regards injury but in all bone infections

Fracture beneath the upper epiphysis of the humerus is

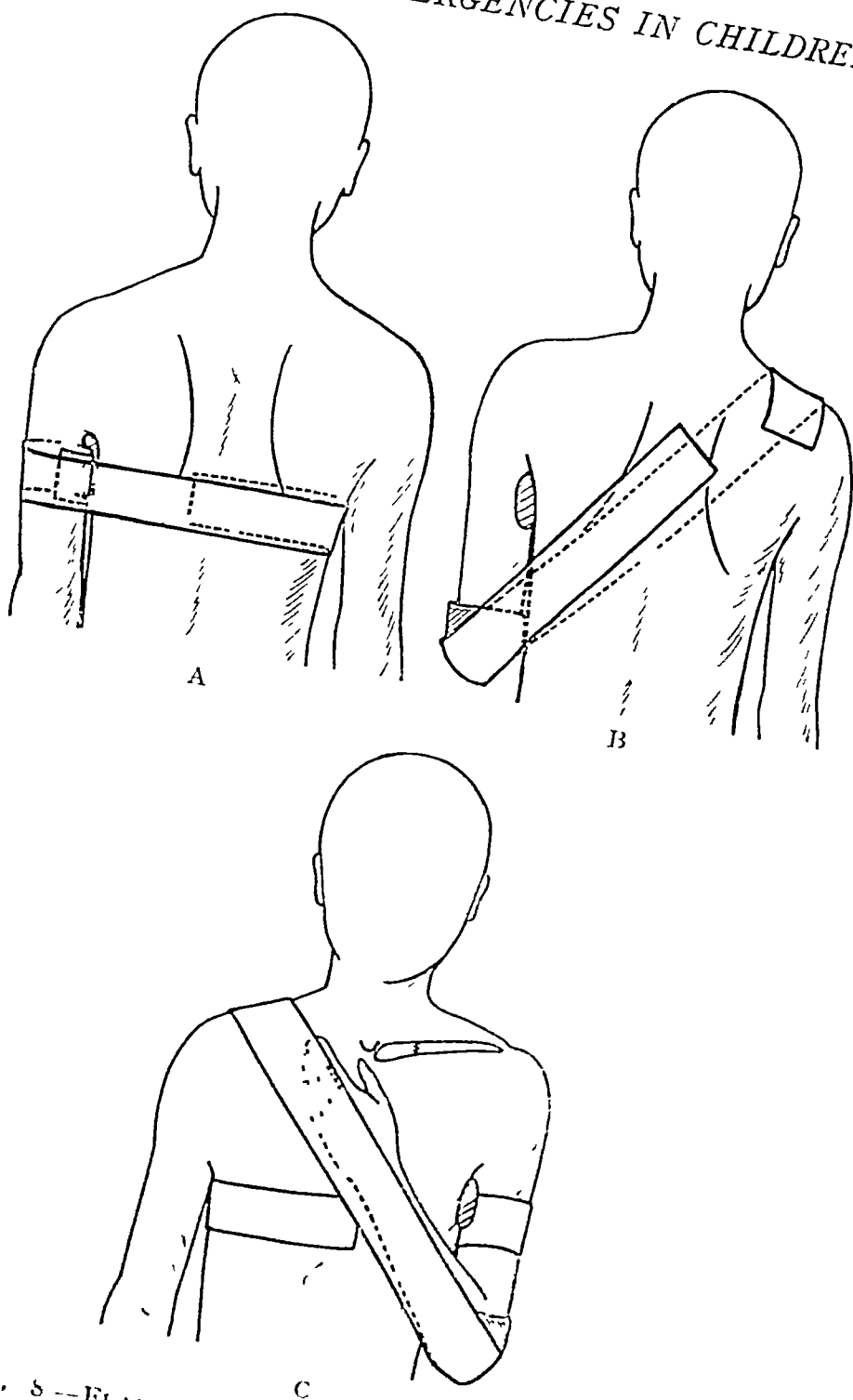


FIG. 8 --FRACTURE OF THE CLAVICLE METHOD OF APPLICATION OF STRAPPING  
For description see text

an uncommon one and there is rarely any gross displacement. There is no need as is the case in adults to keep the arm in abduction for fear of obtaining a stiff joint in the position of adduction and it is usually sufficient to fix the arm to the side with strapping after first placing a pad of wool in the axilla. The chief interest of fractures in children in this situation is that this is one of the sites in which a solitary cyst of the bone may occur and predispose to the fracture. The extent of the cyst will determine whether operation should be performed and the cyst contents and its lining removed but if there is any doubt operation should be deferred for it is quite astonishing how such a cyst which may be so large that the upper end of the humerus is converted into a thin shell may become obliterated completely during the healing of a fracture which passes through it.

**Fractures of the Shaft of the Humerus**—These are rare in childhood. Accurate apposition should be obtained and the arm immobilised in a plaster of Paris splint which envelops the forearm and the upper arm and is continued as a light spica round the corresponding shoulder joint. The plaster needs to be not more than three or four layers in thickness and should be retained for a period of four weeks.

In these cases the proximity of the musculo-spiral nerve to the site of fracture must be borne in mind. Should there be any paralysis of the wrist extensors whether partial or complete as an immediate complication open operation is indicated. Operation should also be performed in cases in which the paralysis develops within the first few days after the injury.

**Fractures of the Lower End of the Humerus**.—Fractures immediately above the lower humeral epiphysis give more anxiety in their treatment than all other fractures of long bones together. This is due to the danger of the occurrence of myositis ossificans and far worse Volkmann's ischæmic



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contracture (myositis fibrosa), and it is to the prevention of these two sequelæ that attention must be directed. Both may be prevented. Myositis ossificans may be cured, but Volkmann's ischæmic contracture will be permanent.

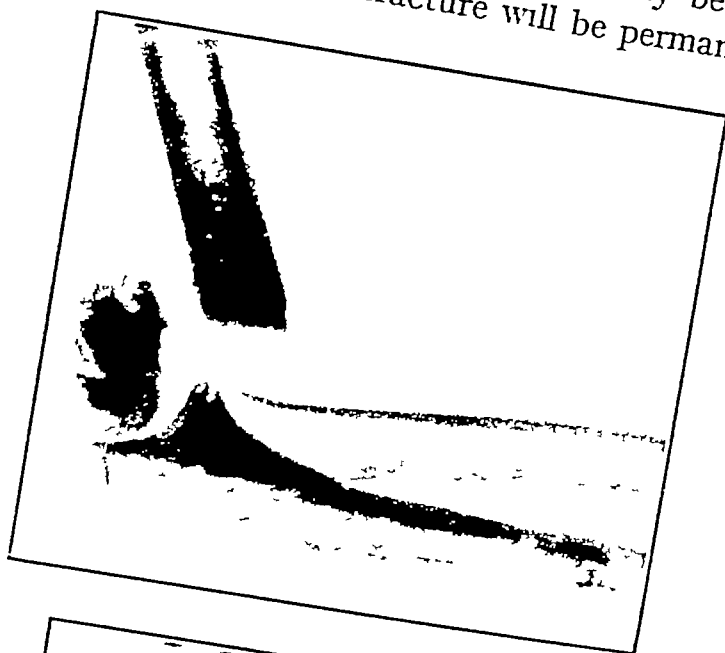


FIG. 9. TRANSVERSE FRACTURE AT THE LOWER END OF THE HUMERUS. POSITION BEFORE AND AFTER REDUCTION.

The most common fracture is a transverse one immediately above the epiphysis, with displacement of the latter backwards upwards to the inner or outer side, with rotation both in the antero-posterior and lateral planes (fig. 9).

A second type of fracture is avulsion of the internal epicondyle an injury not uncommonly associated with backward dislocation of the elbow.

After fracture of the lower end of the humerus the arm rapidly becomes very swollen especially in the young child. Little can be gained from the old classical methods of clinical examination because the bony points are so obscured by the swelling and an immediate X ray should be done. With the diagnosis confirmed reduction should be attempted as early as possible after injury under gas or ethyl chloride anaesthesia. The main displacements are backwards and upwards and these must be corrected. The swollen elbow is grasped in the right hand and the left hand holds the upper end of the humerus and the elbow is pulled down. Crepitus will be felt during this manipulation. While extension is being applied direct pressure forwards is put on the forearm in an effort to carry the lower fragment back to its normal position. The forearm is now flexed and the arm held in the flexed position by means of strapping and a flannel bandage (see below) and an X ray is taken to check the anatomical result obtained.

*Difficulties and Dangers*—In the young child the swelling may be so great that these manœuvres will be extremely difficult. Occasionally the skin is raised up to form large blebs covering the joint. Because of the presence of the swelling flexion may be considerably impeded and it will be impossible to flex the elbow much beyond a right angle and the position sometimes depicted by diagrams in text-books in which the joint is so flexed that the forearm and upper arm lie in close contact cannot be approached with safety. No attempt should be made to force the forearm into flexion against resistance for this is the way to expose the child to the complication of Volkmann's ischaemic contracture. Before the bandage is applied one must ascertain that the radial pulse is not obliterated and one should feel

for this again after fixation. It is improbable that contracture will follow if the radial pulse can be felt, but this does not give absolute security against it, for recent work tends to show that the vascular obstruction which is the prelude to Volkmann's contracture is venous and not arterial. The arm is held in flexion by a figure of eight flannel bandage

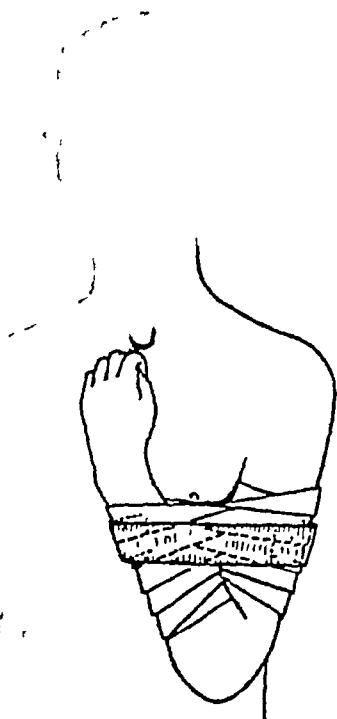


FIG. 10.—TREATMENT OF FRACTURES OF THE LOWER END OF THE HUMERUS

After fixation in this manner a well-fitting sling is applied. For description see text.

around the arm a little distance above the point of the elbow. Over this is applied a narrow piece of strapping as an additional security (Fig. 10), and the whole is put into a snugly fitting sling. The hand is examined each day, and at any suggestion of swelling or blueness of the fingers the bandages are immediately taken off and the amount of flexion decreased. Should the swelling be so great at the time that reduction is attempted that flexion cannot be obtained to much beyond a right angle, the flexion is increased each day as the swelling subsides. In the case of the young child this position should be maintained without disturbance for a period of one

month, as immobilisation for this period is the best guarantee against the development of myositis ossificans. The bandages are then taken off and a sling may be worn for a few days. In the absence of complications the child will soon recover full movements. In older children the bandages may be replaced after a period of three weeks by a collar and cuff, the strap between the two being lengthened

each day so that extension is achieved gradually. There may be some delay in recovery of power fully to extend the elbow. This can be aided by encouraging the child to carry a weight about in that hand or by fastening a lead bracelet on the wrist.

*Failure to obtain Reduction by Manipulation*—Should there be gross displacement it may be impossible by manipulative measures to achieve reduction and in such cases open operation must be performed.

**Fractures of Both Bones of the Forearm.**—The junction of the proximal two-thirds and the distal one third of the forearm is the commonest site of fracture (Fig. 11). Frac-

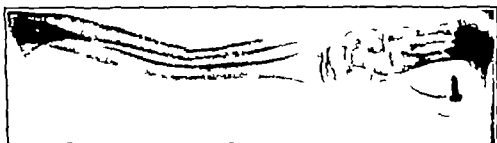


FIG. 11.—FRACTURE OF BOTH BONES OF FOREARM

tures of both bones below this level are unusual in children. Reduction should be attempted under ether anaesthesia and is achieved by pulling upon the forearm below the site of fracture with the forearm fully supinated. The fracture is in most cases a transverse one and the fragments should be felt to hunch upon one another if the manipulation has been successful. The reduction is held while a well padded plaster is applied with the elbow flexed to a right angle and the forearm fully supinated. The plaster extends from the middle of the upper arm down to the bases of the fingers. It is important that accurate apposition should be obtained in fractures of this type because there is some danger of cross union and if the manipulation fails open operation must be

performed. The plaster should remain on for a month and then the child be given a sling to wear.

**Lower End of the Radius.**—A not uncommon type of fracture is that which occurs immediately proximal to the

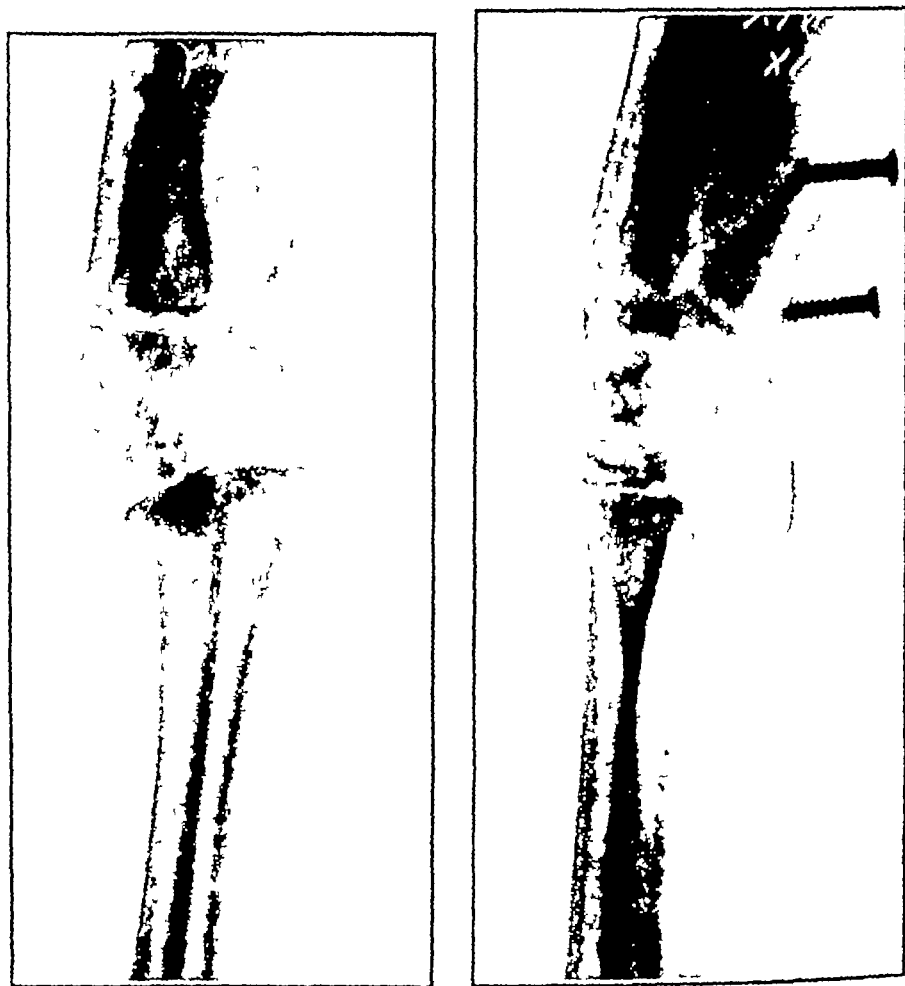


FIG. 12. FRACTURE WITH SEPARATION OF THE RADIAL EPIPHYSIS. BEFORE AND AFTER REDUCTION.

radial epiphysis (Fig. 12). The latter is displaced backwards and rotated backwards after the manner of the distal fragments of the Colles' fracture in adults. Reduction should be attempted under full anaesthesia, and may be extremely difficult to achieve. The reduction should be

maintained by a light plaster splint with the wrist flexed. In this fracture accurate apposition is essential and failure to obtain a good result by manipulation necessitates open operation.

**Fractures of the Carpal Bones**—These are rare in children and do not need special comment.

**Fractures of the Metacarpals.**—These fractures should be treated in the young child by placing a small roller bandage in the palm of the hand and binding the fingers over it in flexion. In older children the method of choice is that in which a strapping extension is placed on all four fingers and attached to a wire hoop which is secured to the wrist by being embedded in a cuff of plaster.

## FRACTURES OF THE LOWER LIMB

**Fractures of the Femur**—Fractures of the femoral neck are exceptional in childhood and usually occur as the result of a pathological lesion. In one such case in a boy of two and a half years fracture occurred through a solitary cyst of the bone (Fig 7 A and B). Treatment in a position of full abduction and internal rotation maintained in plaster resulted in a satisfactory union the cyst being obliterated in the process. Some years later a subtrochanteric osteotomy was done to correct the resulting coxa vara.

Injury to the femoral shaft is very frequently due to torsion and results in a long spiral line of fracture (Fig 13). Considerable overlap may result. In view of the oblique line of fracture it will be impossible by manipulation to get the two fragments to hitch and holding them is a matter of considerable difficulty. In children under the age of three to four years the best treatment is that of Bryant. Under light anaesthesia a strapping extension is applied to both legs and the cords from the strapping pass over pulleys attached to a horizontal bar passing transversely across the

cot. A weight is applied to each, sufficient to keep the sacrum of the child just clear of the bed (Fig 14). In children above this age the manipulative method is as follows:

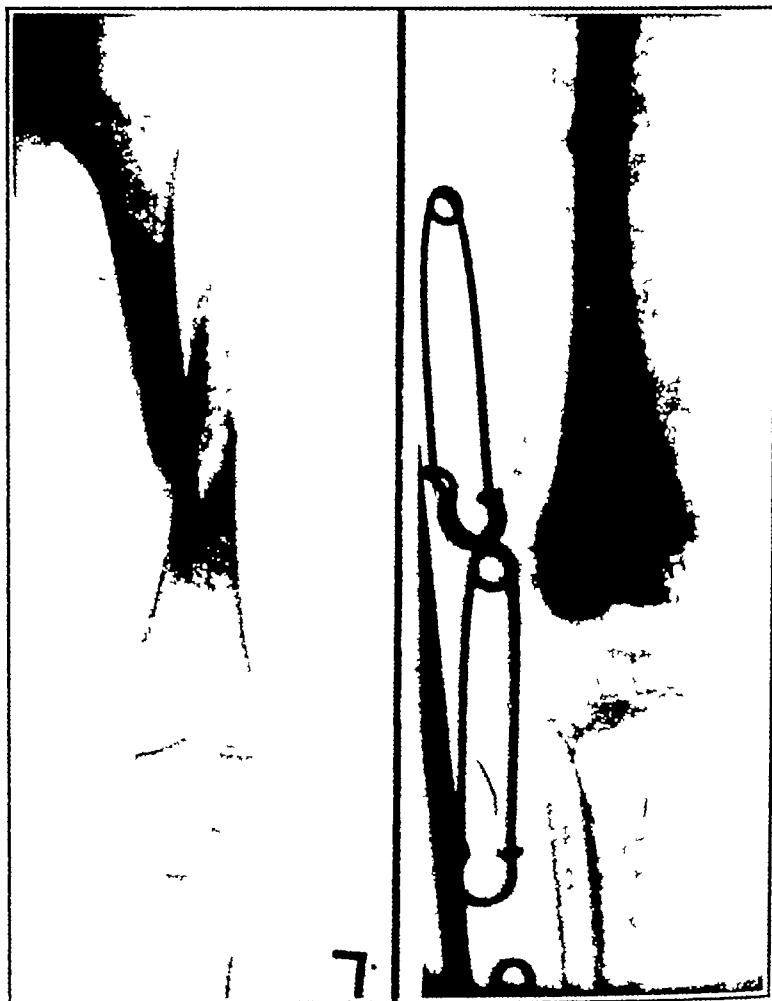


FIG. 14. FRACTURE OF THE SHAFT OF THE FEMUR.

This case was treated by open operation, and the fragments secured by means of a Thomas band.

Under ether anesthesia a strapping extension is applied to the leg, reaching from the upper end of the thigh to the malleoli. The steps of the application of the strapping are shown in Fig. 15. Attention is drawn particularly to the

use of narrow strapping. The strapping should not be more than  $1\frac{1}{2}$  inches in width at the outside and should be so applied that the mid line of the strapping lies just behind the mid line of the leg. Another item of very great importance is to see that at no point do the narrow pieces of strapping put on to consolidate the main extension completely encircle the leg. In this way can strapping sores be avoided.

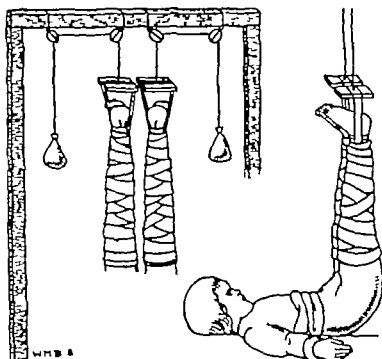


FIG. 14.—TREATMENT OF FRACTURE OF THE SHAFT OF THE FEMUR IN AN INFANT BY BRYANT & MITHOD.

For description see text.

The cotton bandage should be applied firmly over the strapping but the greatest care should be taken to avoid any unevenness likely to cause localised pressure on the skin and make it sore. When the plaster is applied the whole leg is threaded through the ring of a straight Thomas splint and the fracture reduced by direct extension. The distal end of the splint is held against the body of the operator,



and counter-extension is achieved by the ring of the splint pressing upon the tuber ischi (Fig 16). The limb is pulled upon steadily until, by measurement, the leg equals that on the opposite side. The ends of the extension are now wound

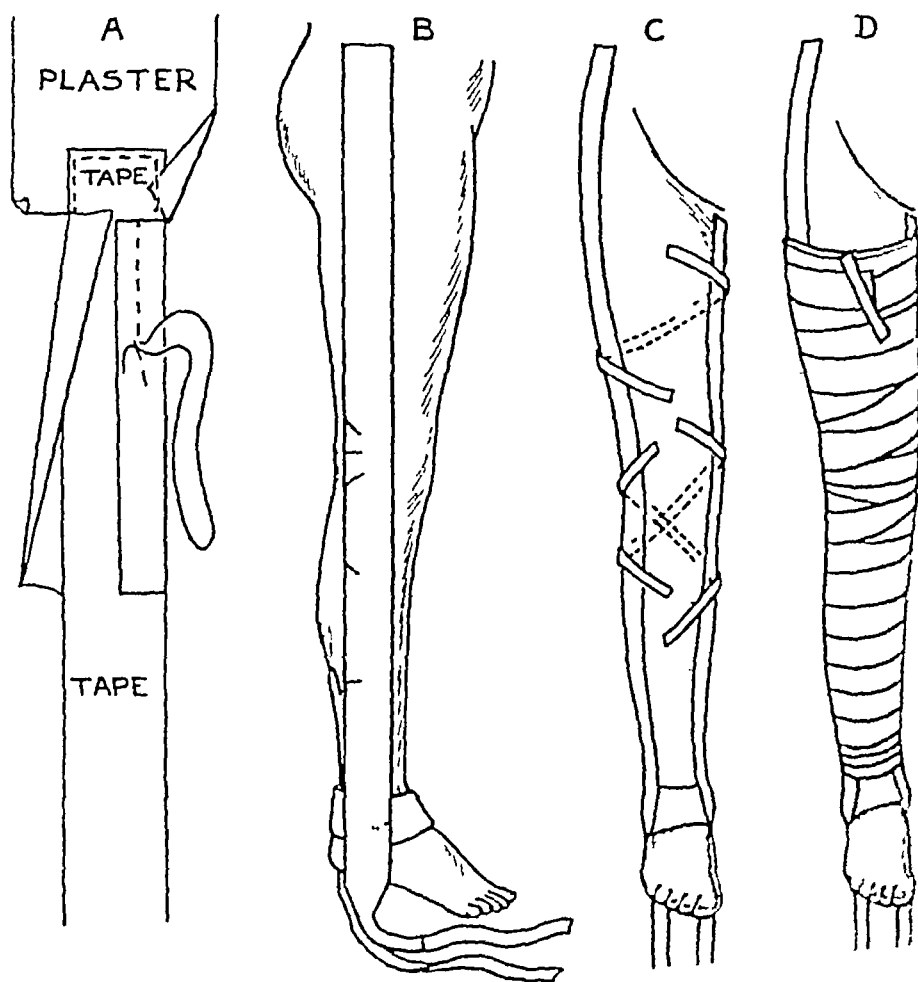


FIG. 15 — THE TREATMENT OF FRACTURES OF THE SHAFT OF THE FEMUR. THE METHOD OF APPLICATION OF STRAPPING.

For description see text

round the splint and tied over the transverse bar, so that a fixed extension is obtained (see Fig 17). The splint is suspended from a Balkan Beam. Should the counter-pressure of the ring against the tuber ischi cause distress

to the patient it may be eased after two or three days by attaching a weight over a pulley to the end of the splint and putting the leg end of the bed on blocks. The splint should be kept on for two months. There is no need for any massage or any attempt to obtain movement at the knee joint as in the case of adults. After two months the child should be kept in bed with the splint removed and three months after injury walking may be attempted.

A considerable amount of latitude in regard to attaining perfect alignment in these fractures is permissible. It is

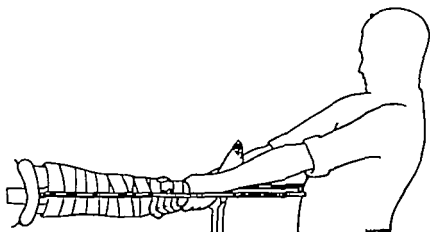


FIG. 16.—REDUCTION OF A FRACTURE OF THE SHAFT OF THE FEMUR

For description see text

impossible to lay down any hard and fast rule with regard to the degree of shortening that demands operative interference but this should not be allowed to exceed  $\frac{1}{4}$  to 1 inch in the average case. Treatment by *weight* extension in a Thomas splint is unsuited to children.

The first aid treatment of fractures of the femoral shaft is a matter of considerable importance. Movement of the bony fragments in so large a bone is calculated to add very considerably to the shock of the accident and no time should be lost in immobilising the limb. If available the

best method is by means of a Thomas splint, with an ordinary meat skewer placed through the boot just below the instep

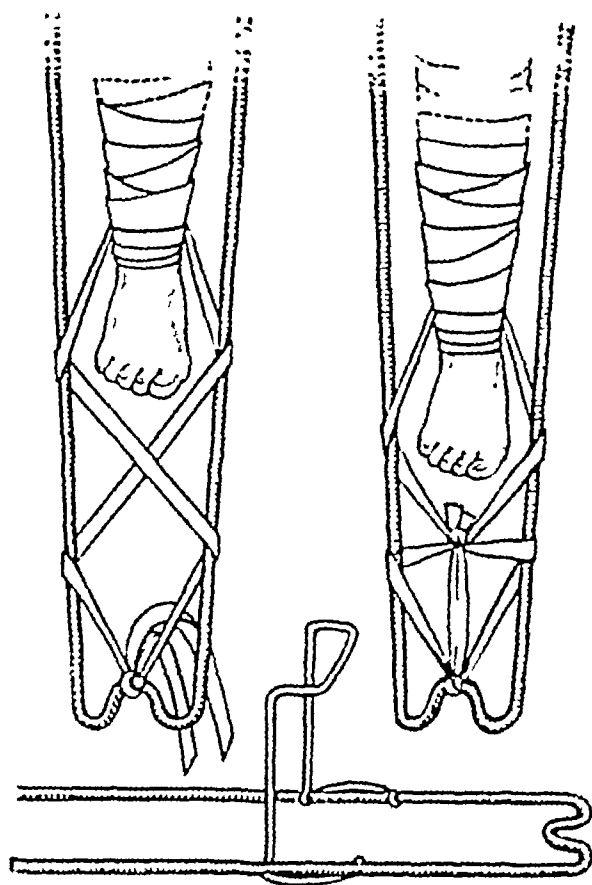


FIG. 17.—FIXED EXTENSION FOR FRACTURE OF THE SHAFT OF THE FEMUR

The ends of the tape are brought round the sides of the splint and tied to the cross-bar at the end. Note how the outer tape passes over the bar of the splint and the inner one underneath. This arrangement helps to correct the tendency to external rotation of the lower fragment. The ends of the tape are tied over the crossing and the extension can be tightened by means of twisting the length of tape between the crossbar and the crossing with a long nail (Spanish windlass). A wire foot piece, as shown in the lowest diagram, is now applied.

Once the splint is on, immobilisation is obtained by means of string firmly securing the skewer to the transverse bar of the splint. When a patient so treated arrives at hospital,

the medical officer should not take off the splint until he is ready to replace it by strapping extension

**Fractures affecting the Distal Epiphysis of the Femur —** Fractures in this situation are excessively rare. The distal epiphysis may be carried backwards into the popliteal space (Fig. 18) or forwards underneath the extensor muscles. In

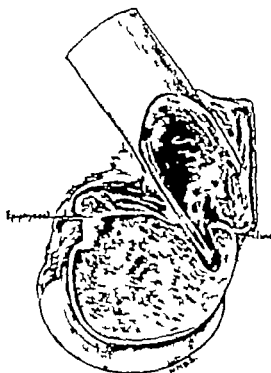


FIG. 18.—FRACTURE OF THE FEMUR IMMEDIATELY ABOVE THE DISTAL EPIPHYSIS WHICH HAS BEEN DISPLACED BACKWARDS

Note how the upper fragment has penetrated the epiphyseal line. The history of this case is not known but the fracture is not a recent one as union has occurred.

the former case the sharp anterior margin of the proximal fragment that is to say the shaft of the bone may be caught up in the periosteum and may act as a bar to reduction. Under such circumstances open reduction will probably be necessary.

**Fractures of the Tibia.**—The most common type of fracture is an oblique one through the shaft of the tibia about the

junction of its upper two-thirds and lower third (Fig 19) If the fibula is not broken, there is rarely any gross displacement, and in any case little improvement can be achieved by manipulation The leg should be put into a plaster

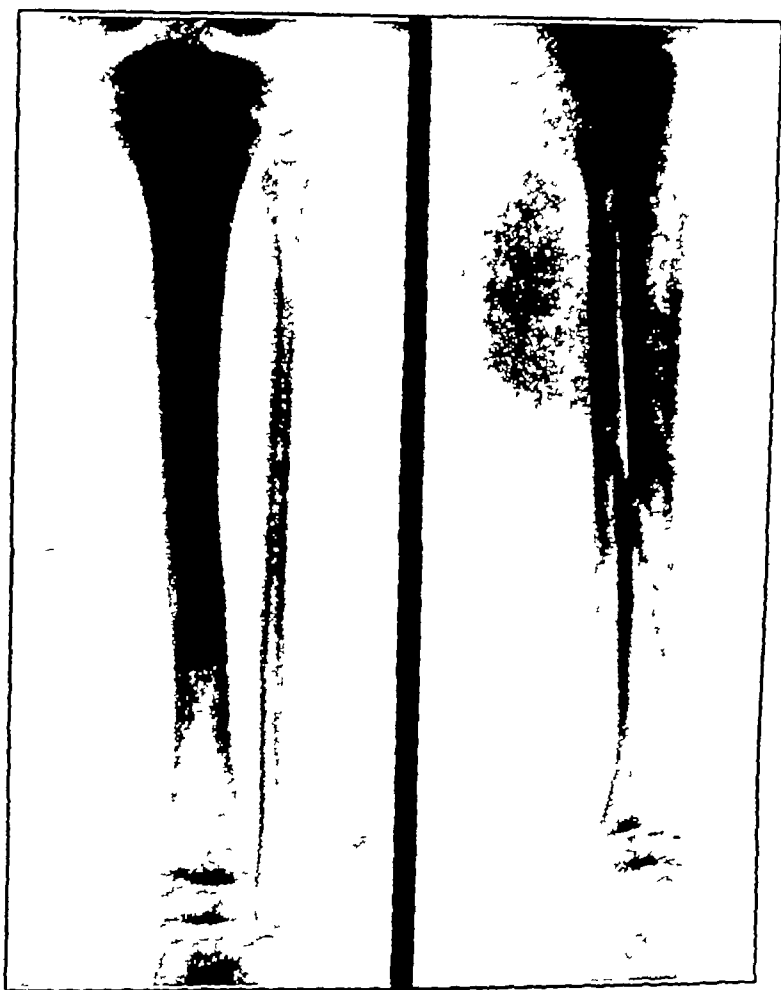


FIG 19—SPIRAL FRACTURE OF THE SHAFT OF THE TIBIA

There is little displacement to be seen in the AP radiogram, but definite displacement in the lateral

which reaches from the middle of the thigh to the toes, with the knee slightly flexed and the ankle at a right angle The plaster should be kept on for two months, after which period the child may be permitted to walk

**Fractures affecting the Lower Tibial Epiphysis.**—This is fortunately a rare injury. Fracture occurs immediately above the epiphyseal line and reduction must be attempted under full anaesthesia and maintained by a well moulded plaster splint (Fig. 20). If marked displacement is still present after manipulation has been attempted open operation must be performed.

**Fractures of the Tarsal Bones.**—These are unusual in children. Rare cases of fractures of the astragalus may demand open operation. Otherwise in the majority of cases fixation in plaster with the foot at a right angle will suffice.

### COMPOUND FRACTURES

As a result of road accidents open fractures of the long bones in children are occurring with ever increasing frequency. The surgeon is confronted in these cases with two problems: the first and most important is the prevention of infection of the wound; the second, the securing of good alignment of the fragments. The latter, though naturally of considerable importance, must be the secondary consideration and for this reason one must make it an absolute rule in all compound fractures not to attempt to expose the bony fragments at operation in order to put them in good position, although this is a very great temptation to the operator. Furthermore, no form of internal splintage, whether it be made of bone or metal, should be employed.

In all cases of compound fracture of the long bones the treatment is operative. Before proceeding with the operation, however, it is very important to allow the patient to recover from any shock associated with the accident and to make certain that there are no other injuries present which contra-indicate the giving of a general anaesthetic. This applies only to those cases in which there is no severe bleed-

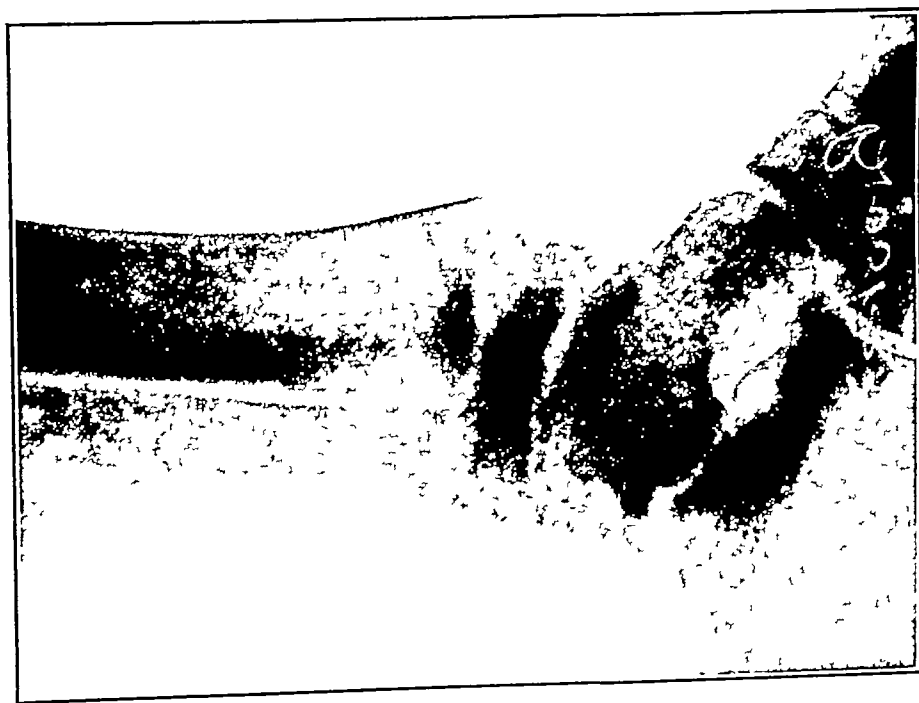


FIG 20—FRACTURE WITH DISPLACEMENT OF THE LOWER TIBIAL EPIPHYSIS BACKWARDS  
BEFORE AND AFTER REDUCTION

ing The period of time which must be allowed for recovery will vary considerably with each individual case but one should err on the side of delay rather than the reverse despite the fact that the later the operation is performed the more chance there will be of sepsis establishing itself in the wound It is customary to allow in the average case some five to six hours before undertaking operation Mean while the wound should be covered with a copious dressing soaked in an antiseptic such as one in two thousand per chloride of mercury and the limb should be immobilised in wooden splints This is a most important consideration for although the splint will make no difference to the subsequent position maintained in the fracture yet its use will tend to diminish the degree of shock present

### The Treatment of the Wound

In cases where the wound is small and clean and has been made as is frequently the case in fractures of the tibia by pointed fragments of the bone itself it is justifiable to excise the skin edges and to sew up the resulting wound without drainage. In the greater number of cases however there is a lacerated wound of varied extent in which road dirt or portions of clothing are present Such cases demand a very careful toilet A gas and oxygen anæsthetic is given and one starts first by washing the skin around the wound with warm water and ether soap—a small soft nail brush is useful for this purpose—and a sterile dressing is placed immediately over the wound while this is being done. The skin is then dried with sterile gauze and then with alcohol acetone or surgical spirit The whole is surrounded by sterile towels and the dressing removed from the wound The skin edges are excised a strip one-eighth of an inch in width being cut around the whole circumference of the wound This is best done with a sharp Bard Parker knife Any torn muscle or



fascia is excised, but no attempt is made to excise the wound *in toto*. Small fragments of bone lying loose in the muscles or in the fascial planes are removed, and a careful inspection is made in every part of the wound for any particle of road dirt or of clothing. The most minute care is necessary, and it may take the surgeon an hour or longer in order to complete this toilet, but no pains must be spared in making certain that nothing likely to act as a source of infection is left in the wound. Bone itself is not exposed any more than is absolutely necessary, and, as already mentioned, there must be no attempt to manipulate the bones into position by grasping them in bone forceps. In cases where the skin has been stripped up over a large area and hangs loose, the flap must be trimmed and so reduced in size that there is no danger of its edges sloughing. In large wounds it is my practice to use Carrel-Dakin's method of continuous irrigation. If the wound is a comparatively small one, however, it is probably inadvisable to put in any drainage tubes, but to pack it lightly with a copious dressing wrung out in Dakin's solution. In all cases the child must be given a prophylactic dose of anti-tetanic serum.

### **The Treatment of the Fracture**

In fractures of the lower limb, which form the great majority of compound fractures, skeletal traction by means of a pin is, in my opinion, the method of choice. In the young child it is unwise to pass the pin, which should be of small size, through the bone, but it should be placed behind the tibia and in front of the tendo Achilles, immediately above the os calcis (Fig 21, A). This is suitable for obtaining traction sufficient to control a fracture of the leg in the young child. The whole leg is now placed in a straight Thomas splint and traction obtained by the fixed method rather than by weight extension.

These details of treatment have been described in their order of importance but it is convenient to reverse the order of their performance. Taking a compound fracture of the tibia as an example the method of procedure is as follows

The patient is anaesthetised by gas and oxygen only. The original dressing which is placed on in Casualty is not disturbed but the clothing is completely removed from the limb. The wound area still covered by its original dressing is shut off by a sterile towel from the region of the ankle and the foot. This region is now carefully purified using ether soap and then acetone and finally iodine and is surrounded with sterile towels. A small incision is made with a knife immediately in front of the tendo Achilles and a Steinman's pin of the smallest size is introduced until it pushes

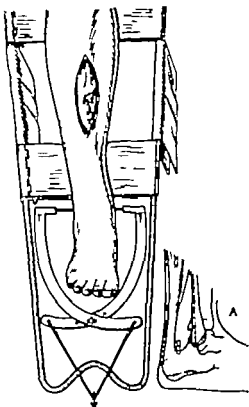


FIG 21 —SKELETAL TRACTION APPLIED FOR A COMPOUND FRACTURE OF THE TIBIA

The small diagram (A) shows the position of the Steinman's pin in relation to the os calcis. For full description see text

up the skin on the other side. The skin is drawn down over the prominence made and a small stab incision permits the pin to be pushed through until an equal amount projects from either side of the leg. The small wounds at the entrance and exit of the pin are covered with collodion and a Steinman's caliper is placed in position (Fig 22). An assistant now holds this and applies traction and maintains

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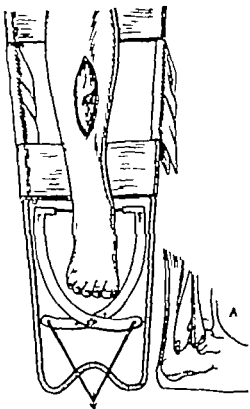


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this throughout the rest of the operation. This serves to steady the limb and to prevent creating additional shock during the toilet of the wound by unnecessary movement of the fragments of bone. The foot and the pin are now covered with a mackintosh and the wound toilet is begun, and when the skin has been purified, gloves are changed and the technique described above is followed.

**After Treatment.**—There is a general tendency to change the dressing in these compound fractures too frequently

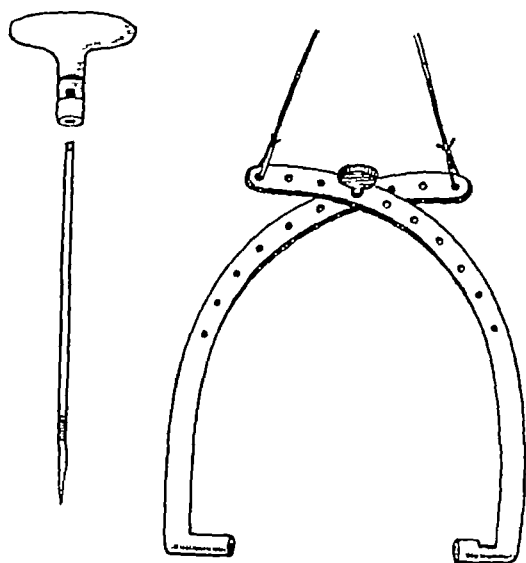


FIG 22 —STEINMAN'S PIN WITH INTRODUCER AND CALIPER

If the Carrel-Dakin method be employed, then the dressing should not be done more than twice in each week. The tubes should be taken out and a freshly sterilised set placed in. Furthermore, if there are no signs of sepsis in the wound, the method should not be continued for more than ten days to a fortnight, but should be replaced by a copious wet dressing. In those cases in which the Carrel-Dakin method has not been used there is again little need to change the dressing more often than once every two or three days. It is important that the dressing used should be copious, and

no attempt should be made to economise in this direction. When the wound is closing up and becoming covered with granulation tissue which even in very large wounds should take place before the end of three weeks to a month the pin should be removed and the whole limb encased in plaster. The wound itself is covered over with a generous layer of gauze and no window is cut in the plaster so that the epithelium being undisturbed is given every opportunity of covering over the raw surface. The actual technique of this part of the treatment is as follows.

After the dressing has been done a plaster slab is made with an ordinary plaster bandage and is moulded to form a gutter for the back of the leg and the foot and is allowed to harden. The pin is then removed taking care to sterilise with spirit the end which has to be drawn through the leg. A dressing is applied to each of the two small wounds behind the ankle and the limb is then completely encased in plaster. The plaster need only be a light one and should be changed at the end of a fortnight to three weeks. When the wound is completely healed the after treatment will be similar to that of closed fractures. In dressing the wound the greatest care must be taken to shut off the metal bars of the splint so as to prevent any secondary infection of the wound and for this purpose during the time that the dressing is being done the splint on either side of the wound should be draped with towels wrung out in 1/20 carbolic. The successful issue of these cases depends very largely upon the avoidance of secondary infection.

**The Winnett Orr Method.**—Mention must be made of the Winnett Orr method of treatment of compound fractures in which the limb is encased in a complete plaster splint after preliminary cleansing of the wound. Vaselineised gauze is used as in the treatment of acute osteomyelitis.

In Orr's hands this method has apparently given satisfactory results.

**DISLOCATIONS**

Traumatic dislocations are comparatively rare in children. The most frequent of them is probably that of the elbow-joint. The dislocation is usually a backward one, the ulna and radius disarticulating from the lower end of the humerus and passing posteriorly so that the coronoid process of the ulna lies behind the trochlea of the humerus. The condition differs in two particulars from that in adults. In the first, avulsion of the internal epicondyle of the humerus not uncommonly accompanies the dislocation and may act as a bar to reduction. Secondly, despite the fact that no actual fracture accompanies the dislocation as far as can be determined radiologically, there is a definite risk of myositis ossificans complicating the injury. For this reason it is advisable to rest the elbow in full flexion for a period of three weeks after reduction. In those cases in which the internal epicondyle has been avulsed open operation will be required.

## CHAPTER V

### INJURIES TO MUSCLES AND TENDONS

#### SUBCUTANEOUS INJURY

SPONTANEOUS rupture of muscles or their tendons is practically unknown in children for the factors which predispose to their occurrence are lacking. Two tendons however are not immune from subcutaneous rupture in children. These are the long extensors of the fingers and the extensor longus pollicis.

#### Rupture of the Long Extensors (Mallet Finger)

The site of rupture of the extensor tendon is at or near the insertion of its final slip into the base of the distal phalanx of the finger. As a result of the rupture the action of the flexor profundus is unopposed and the tip of the finger is held in a flexed position which has earned for it the name of *mallet finger*. The injury is usually produced by a combination of muscular and external violence. A not unusual way in which the rupture is caused is by a badly judged attempt to catch a ball. The hand is held with the fingers outstretched and taut and the ball hits the tip of one of the fingers instead of falling into the palm and the taut extensor tendon snaps. As would be expected the longest finger (the middle finger) is most commonly affected. In the large majority of cases of *mallet finger* the lesion in the tendon occurs immediately proximal to its insertion to the bone but occasionally the tendon itself is not ruptured but the bony spur at the base of the phalanx to which it is



attached is pulled off (disinsertion) The distinction between the two will be made by X-ray examination (Fig 23)

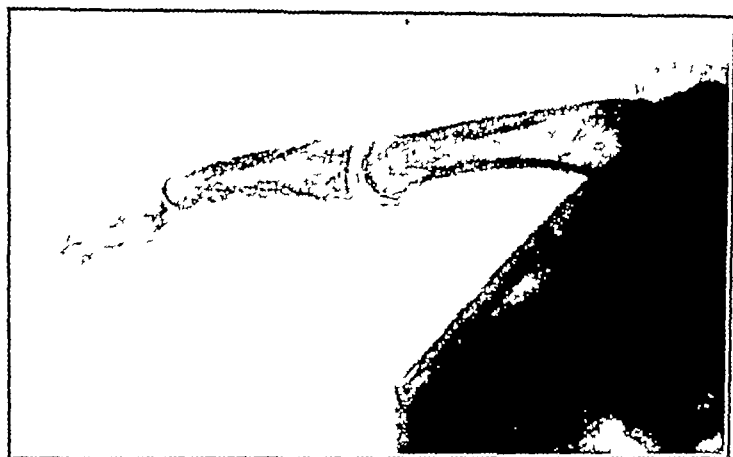


FIG 23 —MALLET FINGER RESULTING FROM DISINSERTION OF THE EXTENSOR TENDON

A portion of the articular margin of the distal phalanx is broken off

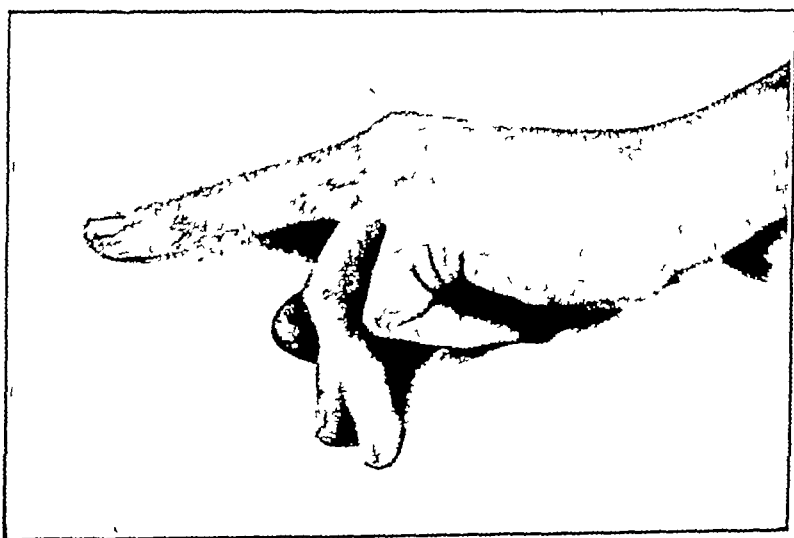


FIG 24 —OPERATION FOR MALLET FINGER

Result obtained in a boy aged twelve years, whose injury had been left untreated for fourteen days

The success of treatment depends entirely upon how soon it is applied after the accident The essential point is to

fix the affected finger in a flexed position into the palm of the hand with the distal joint hyperextended. The finger is held in this position by strapping for a period of three weeks and is then allowed to straighten. A small metal splint or a light covering of plaster of Paris supports the finger for a further period of three weeks. Every day lost in the application of this treatment very greatly reduces the prospect of a complete cure. It is doubtful whether the treatment will be of any avail if adopted later than a week after the injury and operation upon such cases is recommended (Fig. 24).

### **The Extensor Longus Pollicis**

Rupture of this tendon is a rare complication of injury to the lower end of the radius in children. The rupture occurs as the tendon crosses the wrist joint and is a late complication of the original injury. It may occur at any time from six weeks to several months afterwards. The tear is nearly always spontaneous or following a very trivial strain and may not give rise to any pain at the moment of rupture. The patient suddenly notices his complete inability to straighten the thumb. The treatment in these cases is operative. The tendon should be explored and united by end-to-end suture or, if this be impossible, by a tendon graft taken from the palmaris longus.

### **OPEN WOUNDS OF TENDONS**

The management of cases of open wounds of muscles and tendons in children differs in no way from that in adults. The tendons of the fingers are easily the most commonly injured and in view of their importance to the efficiency of the individual they demand very careful and skilled attention.

Wounds of the flexors and extensors are about equally common. The treatment is primary suture of the tendon if the wound is a clean one. A recent analysis of the late results of a series of 103 cases\* in patients of all ages shows that, as a whole, injuries of extensor tendons do well after suture, whereas those of flexor tendons do badly. The factor which is responsible for this difference in outlook is the presence of the synovial sheath which surrounds the flexor tendons. The main cause of failure after suture of the flexor tendons is adhesions of the scar in the tendon to its sheath, so that its power of action, even though its continuity has been established by suture, is directed to the point at which it is adherent, and the gliding mechanism is destroyed. The predisposing causes of these adhesions are (a) sepsis, (b) faulty technique, and (c) prolonged immobilisation after suture. How can these factors be eliminated?

(a) **Sepsis.**—It is a mistaken practice to attempt to suture flexor tendons under any but ideal conditions of operating. There is no call for undue haste in performing the suture, and operations in casualty departments as soon as the patient is admitted should be condemned. A delay of two or three days does not affect the ease with which the operation is performed, and gives the opportunity for adequate preparation of the skin. The operation may then be performed under ideal conditions in the operating theatre.

(b) **Faulty Technique of Suture.**—All efforts should be made to obtain as small a scar as possible in the tendon, and to avoid excessive formation of fibrous tissue. Frayed edges must be trimmed away, and perfect apposition of flat surfaces obtained. The finest material allowing of sufficient hold should be used, and for this reason silk or linen thread should take precedence over catgut. The suture should be arranged so that the knot will not come into contact with the sheath of the tendon, but will lie between the ends

\* Edwards, H. C., *Lancet*, 1932, 1, 65

of the tendon after the manner first suggested by Bunnell\* (Fig 25)

(c) **Early Mobilisation.**—If the suture in the tendon is adequately made active or assisted movement immediately after operation should not be feared but encouraged. The general tendency is to keep the finger at rest for too long

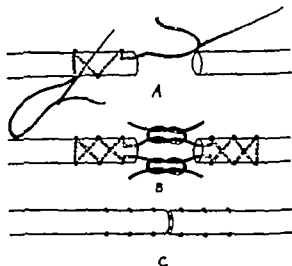


FIG 25—A METHOD OF TENDON SUTURE SUGGESTED BY BUNNELL. The suture material is fine silk, and the knots are so arranged that they lie between the divided ends of the tendon

a period and this allows the scar in the tendon to become adherent to the sheath. The part played by early mobilisation in obtaining correct orientation of the scar is of very great importance and the physiological tension of the tendon must be preserved by splinting the finger in extension and not in flexion. The splint is of course removed at intervals for movement to be practised.

\* Bunnell S *Journ Bone and Joint Surg* 1928 x. 1

## CHAPTER VI

### ACUTE INFECTIONS OF BONES AND JOINTS

#### ACUTE OSTEOMYELITIS

PYOGENIC infections of bone fall into two groups, open and closed. In open infections a wound is present which allows the infecting organism, or organisms—for the infection is not infrequently a mixed one—direct access to the bone. Most of the cases are compound fractures, but the condition may follow an emergency amputation, and is not an uncommon sequel to rib resection for empyema. The whole bone—cortex, medulla and periosteum—is affected, and a periosteomyelitis results. Occasionally a localised area of periosteum may be infected through a wound which goes down as far as, but not through, the bone.

In present-day civil practice open periosteomyelitis has few terrors. Steps are taken to prevent gross infection of the bone in compound fractures by operating upon the case without delay, excising the skin edges, and removing any severely damaged tissue. Infection, if it now occurs, is usually a mild one, and gives rise to little or no constitutional disturbance, for unlike closed osteomyelitis, the products of the infection are able to escape through the open wound. In closed infections the organism may reach the bone in two ways: by direct extension from an adjacent septic focus, or via the blood stream. There are many examples of the former, such as acute mastoiditis from middle-ear disease, alveolar abscess from dental infection, a phalanx in whitlow, and the articular ends of the bones in acute

arthritis The latter condition is most frequently met with in acute infection of the knee-joint following a penetrating wound into the joint

### ACUTE HÆMATOGENOUS PERIOSTEOMYELITIS

Though unwieldy the full title of acute hæmatogenous periosteomyelitis has a great deal in its favour for it stresses two important features of the disease namely that the infection is carried to the bone by the blood stream and that all three components of the bone—periosteum cortex and marrow—are affected.

The disease is essentially one of childhood Investigation of 100 consecutive cases of pyogenic infection of bone of all types showed sixty-one to be blood borne and of these all but five were before the age of sixteen The maximum incidence appears to fall between the ages of thirteen and fourteen, but there is a definite peak between the ages of seven and eight 78 per cent of the cases were in boys \* The tibia femur and humerus were the most frequently affected bones in the proportions of 22 14 9

In the great majority of cases the causal organism is the *Staphylococcus aureus* In the author's series this organism was responsible in 67 per cent of thirty seven cases Other organisms occurred as follows *Staphylococcus albus* and *Streptococcus* three cases each *Pneumococcus* two cases *Enterococcus* one case In three cases cultures from the bone were sterile

The source of the infection is usually obscure but the site of infection relative to the bone as a whole is practically constant It lies in the cancellous tissue of the shaft immediately under the epiphysis (the diaphyseal side of the epiphyseal line) This very important feature is probably

\* Edwards H C *Practitioner* 1929 vol cxxi 298

due to the way in which the nutrient arteries terminate (Fig 26) The terminal branches of the latter do not penetrate into the epiphysis, but turn back towards the shaft, forming a series of "hairpin bends," which are in

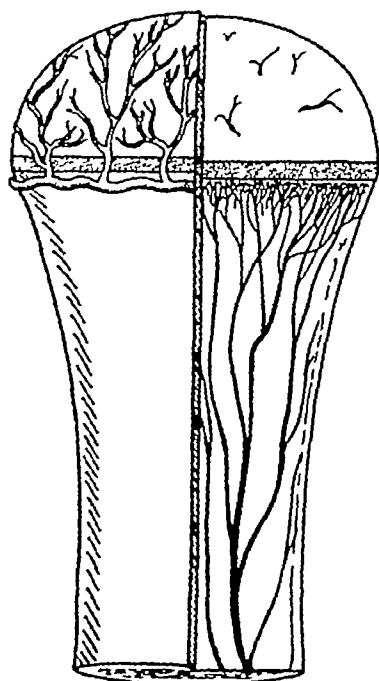


FIG 26 —DIAGRAM TO ILLUSTRATE ARRANGEMENT OF BLOODVESSELS AT THE EPIPHYSEAL END OF THE BONE

The cortex has been removed to display the nutrient arteries, which terminate in loops at the level of the epiphysis The epiphysis itself is supplied by branches arising from the vessels encircling the bone at the epiphyseal level

effect end arteries The epiphyses are supplied by branches from a vascular circle which surrounds the bone at the level of the epiphyseal line From this focus in the metaphysis spread occurs to the cortex, and through this to the subperiosteal region, thence along the shaft of the bone, spread being most rapid underneath the periosteum, which may become separated from the shaft by pus over an extensive area comparatively early in the course of the disease Infection of the medulla occurs by direct spread from the metaphysis, but may also occur secondarily from the periosteum (Fig 27) Spread to the epiphysis itself is not a very common event, and thus the neighbouring joint usually escapes infection In those cases where pus is present in the joint, infection may have occurred by tracking underneath the capsule from its attachment to the shaft in

the diaphyseal region When, however, the subepiphyseal region is *inside* the capsule of the joint, as in the case of the head of the femur and the lower end of the humerus, the joint is always affected

Necrosis of the shaft of the bone occurs with startling rapidity. It is due not to the stripping up of the periosteum but to thrombosis of the bloodvessels in the Haversian canals. In a very short space of time new bone is formed around the old shaft or portions of shaft and the latter is eventually separated from the living bone by granulation tissue forming a sequestrum which lies in a cavity formed by the new bone or involucrum.

### Clinical Aspects

The patient is usually a boy of between seven and fourteen years of age and there is frequently a history of injury preceding the onset of the disease by a few days. The injury in some way determines the site of the local lesion. Without injury it is reasonable to suppose that in some cases the child would have escaped the disease which really is a local manifestation of the fact that the organism is circulating in the blood stream. Given no suitable nidus in which to settle the organisms may be destroyed or dispelled from the body via the urine. Presented however with a *locus minoris resistentiae* which injury may provide the organisms are given their opportunity.

In a number of cases there is a definite septicaemia from the outset and organisms may readily be cultured from

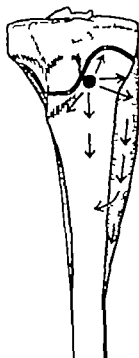


FIG. 27 — SPREAD OF OSTEO-MYELITIS FROM THE FOCUS IMMEDIATELY UNDERNEATH THE EPIPHYSIS

The infection spreads from the cortex of the subperiosteal region and also down to the medulla. The medulla may be reinfected at a lower level from the subperiosteal collection in the manner shown.



the blood There may be no history of injury, for secondary pyæmic abscesses in bone occur when the child is in bed recovering from a first operation for osteomyelitis

Though there is a considerable variation in the intensity of individual cases from the fulminating staphylococcal septicæmia to the mild pneumococcal infection, the clinical aspects of the disease are clear cut As previously stated, the common bones to be affected are the tibia, the femur and the humerus The signs in the case of the upper end of the femur and the lower end of the humerus are those of infection of the corresponding joints and are dealt with elsewhere (p 79)

In all cases the infection is so near to a joint that effusion of fluid into the synovial membrane occurs This may lead the unwary into the mistaken view that the joint is infected, and to opening the joint at operation It is an immeasurable calamity to open the joint unnecessarily, for it will always become secondarily infected from the opening in the bone if this is done It must be borne in mind, therefore, that infection of the joints (viz, the knee and ankle) is unusual. If there is marked swelling and œdema, sufficient to give rise to grave suspicions, the joint may be explored with a needle This must be done *before* the bone is opened

The clinical condition is one of intense toxæmia owing to the tension, and hence rapid absorption, of the inflammatory products inside the rigid bone The high temperature and severe constitutional changes are characteristic It is not uncommon for spells of delirium to occur

The local signs of acute osteomyelitis in a subcutaneous bone such as the tibia are always sufficiently pronounced to make the diagnosis a comparatively easy one The bone is exquisitely tender Gentle tapping upon the bone with the finger away from the infected area will cause pain referred to the latter site

There is no redness of the skin in the early stages, but

the other classical signs of inflammation are always present. The skin over the tibia is in fact often whiter than usual and tense from œdema. The proximal joint will contain fluid and be held in a position of flexion.

When the bone affected is deep seated the diagnosis is more difficult. The lower end of the femur may cause a little difficulty in this respect for there the infection is most liable to start towards the back of the subepiphyseal region near the popliteal surface. In cases of osteomyelitis of the ilium the greatest difficulty may arise. Fortunately this is a very rare situation for the mortality from it is a high one.

The most common diagnostic error is in mistaking acute osteomyelitis for acute rheumatism. This should not be so for except in the case of the upper end of the femur the symptoms of osteomyelitis are not articular. In addition the osteomyelitis is so much more acute with the high temperature and intense toxæmia. A white cell count may be of value but in the fulminating cases of osteomyelitis it may not show a marked leucocytosis. In cases of doubt the bone should be explored. It is only in the milder cases of osteomyelitis that the two are really likely to be confused. Then it does not matter very much for there is no urgency to operate upon osteomyelitis of low intensity. X ray is of no value in the diagnosis in the early stage of the disease.

### Treatment

Immediate operation is demanded in all but the mildest cases. Two considerations are before the surgeon in deciding upon the scope of the operation to be performed—relief of the toxæmia and control of the spread of infection in the bone.

Bone a network of minute canals cannot be drained by incising into it. The ideal in theory therefore is excision—

removal of shaft of the bone from the epiphyses to a point well clear of the infection. Although favourable results sometimes attend this operation, it is not to be recommended as a routine, for the subsequent deformity may be

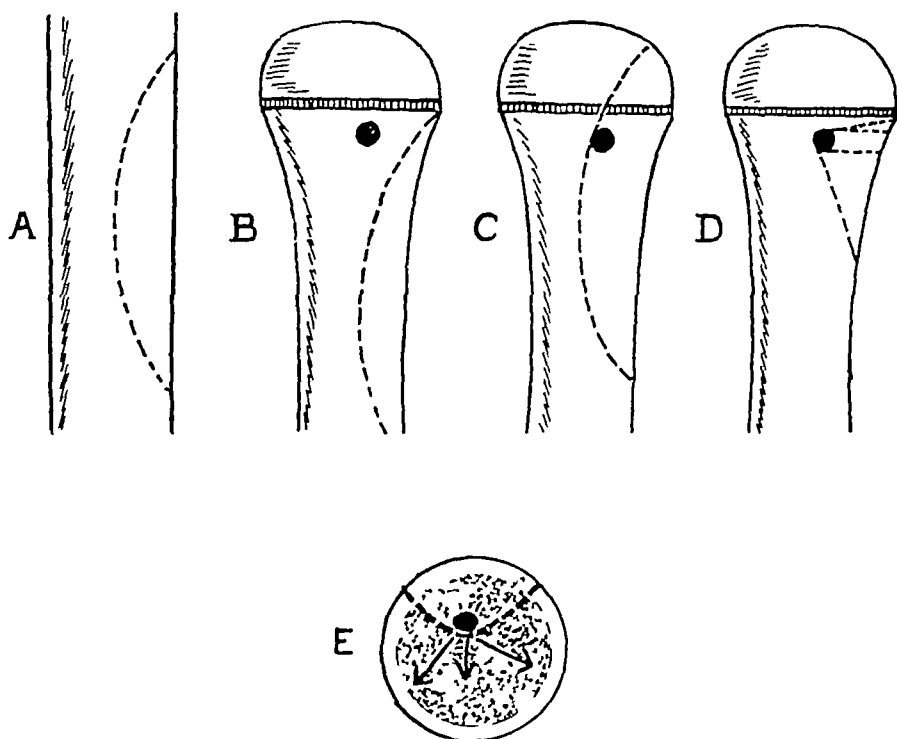


FIG 28

A represents the gutter operation ideally performed. In B such an operation would not adequately drain the infected area in the metaphysis, and C shows that the gutter operation in order to be effective would need to pass through the epiphysis. In D is shown the extent of the operation in the Winnett Orr method of treatment. E shows the way in which infection may spread to all parts in the circumference of the bone, and illustrates the limitations of the gutter operation as a radical method of treatment.

extreme. The old gutter operations are incomplete, for the whole thickness of the bone is affected. Moreover, owing to the proximity of the infection to the epiphysis, a true gutter, that is a trough in the bone without overhanging edges, cannot be made (Fig 28). In any case the

operation has to be followed by a long convalescence with a period of painful dressings unsuited to the ill child. Having consideration for these facts and prompted by the unfavourable results obtained from these methods Winnett Orr has elaborated a new technique. No attempt is made to perform a radical operation on the bone but the tension in the cancellous bone and medulla is relieved by the removal of a portion of the cortex and the limb afforded complete rest by enveloping it in plaster of Paris.

Extended trial of this method shows that the results obtained are at least equal if not superior to older methods as far as saving life and limb are concerned and in addition it has the enormous advantage that the patient is spared the pain and discomfort of repeated dressings. In only one case in the author's experience has there been any inconvenience directly attributable to the method and this was due to a brisk secondary hæmorrhage occurring under neath the plaster which became suffused with blood.

**Operative Technique.**—The anæsthetic of choice is gas and oxygen and if this is not available ether. Owing to the toxæmia and the urgency of operation it is unwise to attempt any premedication with the exception of an injection of atropine. A tourniquet should not be used. Although it is a luxury to the surgeon to have a tourniquet so that the diseased bone can be more readily recognised yet its use definitely predisposes to spread of infection and increases necrosis.

The skin should be purified with methylated spirit followed by iodine or by 90 per cent alcohol and an incision carried down to the bone. It will be found that the subcutaneous tissues easily fall apart because of the œdema. The periosteum will be thickened from œdema and may be lifted up from the surface of the bone by a subperiosteal abscess. The cortex is laid bare over a wide area by lifting up the periosteum which even if no abscess is present will separate

easily from the bone. The exposure is carried right up to the epiphyseal line. This is of paramount importance, as the start of the disease in the bone is immediately underneath the epiphysis. An opening is now made into the cortex, and for this purpose a sharp gouge is best. It can usually be done by hand, but a light hammer may be necessary. The whole thickness of the cortex is cut through until the cancellous bone is reached. In those cases in which no pus has tracked through underneath the periosteum, pus will be found under tension in the cancellous bone. It should be gently wiped away with a small pledget of gauze and no attempt should be made to curette the medullary cavity with a sharp spoon. The cortex should be further removed towards the centre of the shaft until healthy bone is met with, so that the whole of the infected area of medulla is opened. Until the healthy bone is cut into, very little bleeding will occur, owing to the thrombosis of the vessels in the Haversian canals. In early cases it will often be difficult to find the area of infection, the tendency being to open the cortex too far away from the epiphyseal line. It is on this account that the epiphyseal line must be exposed and the opening into the cortex made in proximity to it. The greatest care must be exercised not to open the joint cavity. Nothing further should be attempted at operation, but the cavity resulting should be dried with 90 per cent alcohol and the wound gently packed with ribbon gauze impregnated with sterile vaseline. If the surgeon has not got this in stock at the time, it is quite easy to prepare it by placing a roll of gauze in a jar of vaseline and sterilising it in the ordinary way. As the vaseline melts it impregnates the gauze. It will be found impossible to pack the cavity tightly owing to the presence of the vaseline, and the gauze is loosely piled up until it fills the wound and overlaps the edges to a considerable extent.

The limb is now ready for plaster. A generous packing

of sterile cotton wool is first put on and the plaster applied. In the case of the lower end of the tibia the plaster must reach from the toes to a little above the knee-joint in disease of the upper end of the tibia or of the lower end of the femur from the toes to the gluteal fold and in the case of the upper end of the femur a plaster spica must be used.

In a number of cases in which the disease has been present for some time before operation is undertaken a sub-periosteal abscess may be opened. In this case a track will usually be found leading down from the cortex into the medulla and this track should be widely opened. In cases where no track is to be found then a hole must be made *de novo* with a gouge. Although the author has many times limited the operation to incising the abscess in the periosteum and doing nothing further he is satisfied that the extent of necrosis of the bone is better controlled if after incising from the abscess the cortex is opened in the manner described above.

The plaster is left on for three to four weeks. By this time it smells badly and is discoloured from the discharge which has found its way through it from the wound. When the plaster is removed at this stage it is usual to find a healthy red area of granulating tissue with a sinus leading down from it towards the bone. The skin around the wound is cleaned. The wound is gently repacked with vaselined gauze and a further plaster is applied and left on for the same period. At the second dressing it is helpful to have an X ray taken. This will show the extent of the necrosis and will give evidence as to the presence of sequestra. If the latter are present—and this is usually the case—they may be conveniently removed at this stage. As a rule they are small and separate easily.

A third plaster is applied following the same technique and successive plasters are put on in the same way until the wound is healed.

The child must stay in bed throughout the whole of this

treatment, or at all events until the wound has contracted to a very small opening

**General Treatment.**—In this disease the operation is the main treatment, and there is very little one can do from the general standpoint apart from liberal administration of fluids and glucose to limit the toxæmia. During the acute stage sera and vaccines are to be avoided, at all events in staphylococcal cases, which easily form the majority. In the author's opinion also intravenous antiseptics such as mercurochrome are of no value

### ACUTE INFECTIONS OF JOINTS

Organisms may gain entry into a joint through an open wound, or by spread from an adjacent focus, or, finally, via the blood stream. Arthritis caused by organisms from a focus within the body gives rise to etiological problems not shared by cases in which the organisms gain entry through a direct wound into the joint, and it is of advantage, therefore, to divide up acute arthritis as a whole, like osteomyelitis, into open and closed types

### ACUTE INFECTIVE ARTHRITIS (OPEN)

Infection of joints associated with an open wound is comparatively uncommon in children. Owing to its thin covering of soft parts and its exposure to trauma, the knee-joint is the most frequently affected. Organisms may gain entry through an extensive wound in and about the joint, such as may be sustained in a road accident, or by means of a stab wound from a dirty sharp-pointed instrument, or, finally, as a result of improperly performed operations upon septic foci in the neighbourhood of the joint. The latter should, of course, never arise. A recent case of acute arthritis of the knee-joint, in which the child ultimately

lost his leg followed the opening of a boil situated above the patella and immediately over the suprapatellar synovial pouch. In following the dictates of free incision and drainage for sepsis the operator had carried his knife through the base of the boil through the aponeurosis of the muscle and into the synovial cavity. Such an accident may very easily occur unless extreme care is taken in the opening of small abscesses in this situation. It is indeed frequently a matter of difficulty in such cases to be certain whether or no the infection is outside or inside the joint because any acute inflammatory processes in the immediate neighbourhood of the synovial membrane will induce a reactionary exudate of synovial fluid and thus the joint itself will become distended. The unwary may thus be led to think that he is dealing with a true acute arthritis. It will be noticed in these cases however that the inflammatory mass is a superficial one and is limited to a comparatively small area. Moreover though the movements of the joint will be affected to some degree there is not the extreme pain in movement characteristic of acute arthritis. Furthermore the constitutional symptoms will not be so marked. Should any doubt arise in the mind of the surgeon dealing with such a case as to whether or not the joint is affected an exploratory puncture with a needle should be made as far as possible from the maximum area of swelling and tenderness and some of the synovial effusion withdrawn. In cases where the effusion is purely a reactionary one it will be clear or only very slightly turbid.

In the case of badly lacerated wounds attention must be given to the prevention of sepsis and the principle of treatment described for open fractures should be followed (see p 55). The treatment of puncture wounds of the joint will depend very much upon the nature and state of the causal instrument. Should this be a clean object or very small and sharp-pointed such as a needle it will



suffice to keep the leg at rest and to await developments. It is probable that the synovial membrane, like the peritoneum, possesses a certain degree of antibactericidal properties, and in such cases this should be relied upon for the suppression of any minor degree of infection. Thus the leg is immobilised and a back splint and foot-piece applied and the course of the case carefully watched. There is certain to be synovial effusion in all cases in which the joint has been penetrated, but in cases in which infection is absent there will be no associated acute pain in the joint and no marked rise in temperature. When the puncturing agent is known to have been a dirty instrument and a jagged puncture wound has resulted, with signs of contamination around its edges, then it is advisable at the outset to operate upon the case in the manner adopted for compound fractures. Under gas and oxygen anæsthesia the track is explored, the skin edges are excised and a careful toilet of the wound is performed. The tear in the synovial membrane is examined and any frayed portions removed with scissors. The resulting wound in the skin should be left partly open and a small drainage tube inserted reaching down as far as the tear in the synovial membrane. The operation will be made very much easier if a tourniquet is used, and it should be borne in mind that in all these cases of wounds by soiled instruments a prophylactic dose of anti-tetanic serum should be given. When signs of acute arthritis develop after an interval of a few days, following an open wound into a joint which has since healed, the treatment to be described for acute arthritis in general is followed.

#### **ACUTE INFECTIVE ARTHRITIS (CLOSED)**

Easily the most common form of acute arthritis in children is that in which the organism is carried to the joint by the blood stream. The primary focus which constitutes the

source of the organism is as in acute osteomyelitis usually obscure. In others however the source is obvious and this applies more particularly to the newborn child. Thus in acute arthritis of the knees in two newborn babies recently seen the source of infection in one was a whitlow and in the other a carbuncle of the lip. A more usual cause for arthritis in the newborn is umbilical sepsis. In these cases as in older children the condition is a pyæmia and more than one joint may become affected.

In blood borne infection of joints the organisms may be carried either to the articular end of the bone or bones concerned in its formation or to the synovial membrane and the subsequent spread emanates from these points of infection respectively. If the infection is first carried to the bone with subsequent spread to the joint then we are dealing primarily with acute osteomyelitis. Whether or not the joint becomes infected secondarily will depend almost entirely upon whether the focus in the bone lies inside or outside the joint. Thus we find that acute

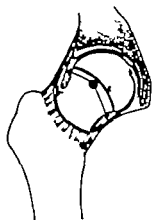


FIG 29 —ACUTE SUPPURATIVE ARTHRITIS OF THE HIP-JOINT

A window has been cut to show how the epiphysis and the subepiphyseal region lie completely within the synovial cavity of the joint. Thus osteomyelitis affecting the neck of the femur is always complicated by acute arthritis the spread taking place in the manner shown.

osteomyelitis affecting the neck of the femur a common situation is always complicated by acute arthritis. This is due to the fact that the neck of the femur is included inside the synovial membrane (Fig 29). The only other joint which shares this property is the elbow in which the lower epiphysis of the humerus lies within the synovial membrane. Conversely acute arthritis of the knee-joint for example

is a comparatively rare complication of acute osteomyelitis of the lower end of the femur or upper end of the tibia for the reason that both these situations are outside the joint itself. As has been pointed out in dealing with acute osteomyelitis, the knee-joint does not invariably escape in these cases, for occasionally there is a direct extension of the sepsis from the focus in the bone underneath the epiphysis directly through the epiphysis itself. In cases of arthritis secondary to bone infection the clinical picture is that of acute osteomyelitis with the addition of the physical signs of joint involvement. When the acute arthritis commences as an infection of the synovial membrane, the condition is a very much milder one, and both local and constitutional disturbances are, therefore, less in degree.

### **Clinical Aspects and Diagnosis**

In cases of infection of a single joint the clinical picture is determined by the local signs of inflammation in the joint and the constitutional reaction to the infection.

The joint is held fixed in a position of deformity. Whatever be the joint affected, this is always a flexion deformity. The joint will be swollen. This will be easily observed in the more exposed joints, such as the knee and ankle, but may be very difficult to detect in the more deeply situated joints, such as the hip-joint. There will be tenderness to direct pressure over the joint and pain on movement. The constitutional reaction will vary according to the severity, and the position within the joint, of the infection. When a staphylococcal osteomyelitis is present, the toxæmia will be very marked as a general rule, but when the infection is, say, a pneumococcal one of the synovial membrane, the general signs may not be severe. The white blood count will vary according to the same factors. There is almost invariably, except in multiple pyæmic cases, a history of

injury which precedes the symptoms by a few days or even in milder cases weeks

As the hip-joint is easily the most commonly affected joint the physical signs may be with advantage described in detail. In the usual type in which the focus of infection is in the neck of the femur two stages of the disease may be recognised. The first is that in which the infection is confined to the neck of the femur and the second that in which the infection has spread through the bone and has involved the joint. The early signs are therefore those of acute osteomyelitis coloured by signs of a mild arthritis in consequence of a reactionary effusion from the synovial membrane. In this stage the diagnosis is one of considerable difficulty and it must be admitted is rarely made. The neck of the femur is so deeply situated that there are no clinical signs to be obtained beyond those expressed by the joint itself. The latter is held in a position of slight flexion and probably in abduction. The effusion into the synovial cavity may be insufficient to yield a visible swelling which is looked for in Scarpa's triangle. The constitutional signs at this stage may not be severe. An X ray will be negative for there is not yet sufficient destruction of bone for it to be detectable by radiography. When the abscess in the bone has ruptured so that there is now pus inside the joint the physical signs are less equivocal and the diagnosis is far more readily made. The joint is held markedly flexed and as a rule abduction has been replaced by adduction. A fullness in Scarpa's triangle denoting distension of the joint will be appreciated on comparison with the opposite side. The joint itself will be held firmly by spasm of the surrounding muscles and very little passive movement will be permitted by the child because of the pain it produces. Though here again the constitutional disturbances will vary according to the virulence of the causal organism as a rule in this class of case the temperature will be somewhere in the region of  $103^{\circ}$  to  $104^{\circ}$  F.

There should be little doubt as to the diagnosis if the signs and symptoms are as well defined as here described, but again in less acute cases doubt may remain, and it is important that a waiting policy should not be adopted because the ultimate result depends so very greatly on early operation. A useful aid to diagnosis is aspiration of the joint. Under an anæsthetic a medium bore needle of a 10 c.c. syringe is entered into the joint cavity at a point above and just to the medial side of the great trochanter (Fig. 30). The needle is thrust inwards and slightly backwards until the neck of

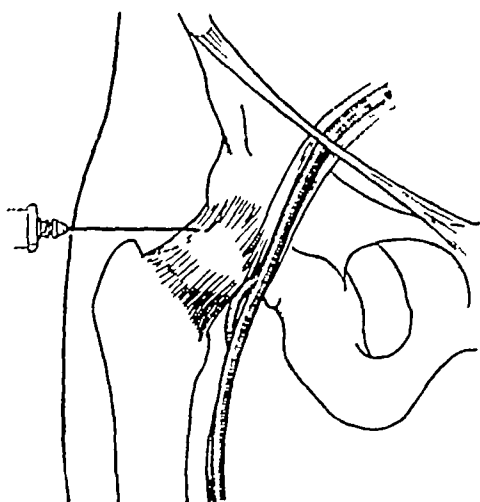


FIG. 30.—EXPLORATION OF THE HIP-JOINT BY A NEEDLE. Note the position of the vessels in relation to the neck of the femur.

the femur is encountered. It is then slightly withdrawn and aspiration is attempted. In the majority of cases—and I say majority advisedly, because this test has failed on occasion—if pus is present in the joint it will be aspirated into the syringe. If a blank is drawn and the signs, local and general, are of sufficient severity to warrant it, one should not hesitate to do an exploratory arthrotomy.

**Operation: Exploration of the Hip-Joint.**—An incision is made downwards and inwards, commencing just below the anterior superior iliac spine. The tensor fasciæ femoris and the sartorius muscles will be recognised and are separated

Separation will be easy because of the oedema present. The incision is deepened still further passing between the glutei on the outer and the rectus femoris on the inner side. The muscles are widely separated by retractors and the capsule of the joint is exposed. This is incised with a narrow bladed knife in the direction of its fibres (Fig 31). As the synovial membrane will probably be greatly thickened by oedema it may be a little difficult to open into the lumen of

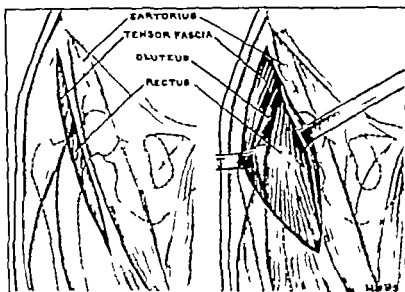


FIG 31 —THE EXPOSURE OF THE HIP-JOINT IN ACUTE ARTHRITIS. The incision lies parallel with the sartorius and just to its outer border. The anterior aspect of the joint is finally exposed by retracting the rectus muscle inwards and is then incised in the direction of the long axis of the neck of the femur.

the joint. Once this has been done pus will be obtained and the incision is extended upwards and inwards as far as is possible. The neck of the femur is now exposed and is explored by means of a blunt dissector to detect any evidence of bone involvement. This is shown by the bone being denuded of periosteum or by a small opening in the cortex which allows the probe to enter into the centre of the bone. If such evidence of bone infection is found a saucer-shaped

depression is gouged so that the centre of the bone is permitted to drain freely into the joint. A drainage tube is left in the wound passing down as far as the joint cavity. The wound should be left widely open, no attempt being made to suture the muscles together. If the joint is distended with pus, then a counter drain should be made posteriorly through the glutei muscles. This may be done by forcing a pair of sinus forceps through the posterior capsule of the joint and through the glutei muscles so that it raises up the skin. A small incision is made over this prominence and the sinus forceps is pushed through, a drainage tube is caught between its blades and pulled upwards into the joint. The leg should be immobilised by means of a weight extension on a Thomas splint so that the hip-joint is in a position of  $20^{\circ}$  of flexion and  $5^{\circ}$  of abduction.

**Differential Diagnosis.**—The outstanding condition entering into the differential diagnosis is that of acute articular rheumatism, which condition figures very largely in many descriptions of the diagnosis of acute arthritis. It seems probable that an undue importance has been given to articular rheumatism in relation to acute arthritis, and as a result a far greater number of cases of acute arthritis are regarded as acute rheumatism and operation therefore overlong delayed, than cases of rheumatic arthritis mistakenly explored for sepsis.

In the case of the more exposed joints, such as the knee, attention has already been drawn to the simulation of acute arthritis in cases of sepsis in the neighbourhood of a joint, and in dealing with acute osteomyelitis the occasional need for needling the joint to prove whether or not pus is present has already been stressed. In mild cases of acute or sub-acute infection of joints, in which both local and general signs are slight, it is advisable to adopt an expectant attitude, and the leg should be immobilised by means of a strapping and weight extension.

## CHAPTER VII

### HEAD INJURIES

#### FRACTURES OF THE SKULL

THE skull of the child is a more elastic and yielding structure than that of the adult and is therefore less liable to fracture. In the infant there is so much fibro-cartilaginous tissue present that when violence is applied to the skull the bones are more liable to bend than to break and hence the usual type of fracture of the vault is a large shallow pond shaped depression. Owing to the greater mobility of the sutures in children the lines of force in violence to the skull are broken up and the fractures are therefore confined to the bone to which violence is applied so that the long radiating fractures involving several bones so typical in the case of injury to the adult skull do not occur. A further point of difference between head injuries in children and adults is that in the former extradural extravasations of blood are limited in extent because the dura mater is adherent to the bone along the lines of suture.

#### Fractures of the Vault

Fractures of the vault of the skull in infants are almost always shallow depressions and there is no associated wound of the skin. In older children the fractures are not infrequently compound but there is not so great a tendency for the scalp to be divided as a result of direct injury as in adults. The indications for immediate operation in fractures of the vault are



- 1 Compound fractures
- 2 Sharply depressed fractures
- 3 Pond-shaped fractures in which symptoms of cerebral involvement are present

**Operation in Compound Fractures.**—The operation is undertaken primarily in order to reduce the risks of secondary infection of the bone and the meninges. We do not advocate débridement of the wound, for it is nearly always a clean-cut one and the vascularity of the scalp enables it to deal with minor degrees of infection. An anæsthetic is given and the scalp in the region of the wound is shaved. Any loose tags of skin are removed and the wound cleaned with ether soap and finally dried with acetone and painted with iodine. The lips of the wound are retracted and the depths fully explored with a probe. If a fracture is present, the wound is enlarged in order that it may be examined thoroughly. Any loose fragments of bone are removed, and if a depressed fracture is found it must be elevated. To do this it may be necessary to make a small trephine hole at its edge so that a lever may be introduced to lift up the fracture (Fig 32). In these cases it is unlikely that there will be any extradural collection of blood, and it is better to avoid a wide exploration. In severe road accident cases the dura itself may be injured and the brain considerably lacerated. In such cases any brain which has been forced through the fracture in the skull should be removed. Such fractures are almost always in the frontal region and the area of brain involved is not a vital part, so that despite the loss of a considerable quantity the child may regain normal health and the mentality may not be impaired. In all save very minor wounds a small drainage tube should be used and retained in position for two or three days. The prognosis, even after severe compound fracture of the skull, is surprisingly good.

**Operation for Closed Depressed Fractures.**—A flap consisting of all layers of the scalp is fashioned so as to give a wide exposure of the fractured area. A hole is trephined in the neighbourhood of the fracture and through this a blunt dissector or in the case of the older child a disc elevator is introduced and the depressed fracture elevated. The flap is replaced and sutured without drainage. In the large pond shaped fractures in infants even where no symptoms are present suggesting pressure upon the

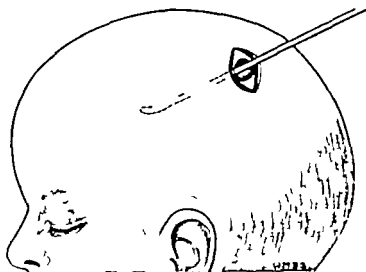


FIG 32.—ELEVATION OF A SHALLOW DEPRESSED FRACTURE IN AN INFANT BY LEVERAGE MADE THROUGH A SMALL TREPHINE HOLE AT THE MARGIN OF THE FRACTURE

underlying brain many are in favour of operation. In instances where convulsions or paralysis occur operation is imperative and should be undertaken at the earliest possible moment. The operation is a very simple one. The skull is exposed by a small incision a little distance from the edge of the pond shaped depression and a small disc of bone is removed. A blunt dissector is passed in through the trephine hole and the fracture elevated (Fig 32).

### **Fractures of the Base**

Fractures of the base of the skull are of rare occurrence in children, and, in contrast to adults, the anterior fossa is more frequently injured than the middle fossa. The importance of the injury lies not in the fracture itself, but in the degree of direct or indirect involvement of the adjacent brain substance. Fracture of the base may be diagnosed in some cases by the early appearance of blood underneath the conjunctiva or, in fractures of the middle fossa, by continued bleeding from the ear. In the majority of cases of head injury, however, such signs are not present and the child is admitted into hospital unconscious, suffering from concussion.

Concussion may be defined as a condition of widespread paralysis, it is probably due to temporary anæmia of the brain caused by compression of the skull. It is impossible to form any opinion as to the extent and nature of the injuries during this stage. In pure concussion there is no gross injury to the brain and the patient will therefore recover completely. The period of unconsciousness varies considerably, but rarely exceeds three hours, and is usually very much shorter than this. In an unconscious child, concussed as a result of injury to the head, one of the following sequences will occur. Firstly, the child will completely recover from the concussion and apart from headache or signs of cerebral irritation will be quite well. Secondly, the child may recover consciousness from the concussion and for a short time be comparatively well with a normal pulse rate. He will then show signs of cerebral compression. After a lucid interval of perhaps an hour, he will slowly lapse into unconsciousness. The pulse rate will become slower, the pupils become unequal, and paralysis of one or other side of the body will occur. The paralysis may be preceded by twitchings of the limbs or by convulsions.

commencing in that side of the body. The condition is due to compression of the brain by an extradural collection of blood and the treatment is operative. Thirdly the child may not recover consciousness but the reflexes return. There will be spastic and later flaccid paralysis of one or more limbs and the pulse rate may be normal or subnormal and the temperature may be raised. In such cases there is present a contusion or laceration of the brain substance. In these cases immediate operation is not likely to be of any value. Fourthly the child may die without showing any sign of recovery from the concussion.

It will be clear that as it is impossible to form any opinion as to what has happened inside the skull when the concussed child is first seen no active treatment can be instituted and nothing should be done beyond keeping the patient warm. Little can be gained from an X ray and lumbar puncture as a diagnostic measure of fracture of the base of the skull should not be used as a routine in children as fatalities have occurred as a direct result of its use. Thus the only indication for immediate operation in fractures involving the base of the skull in children is when symptoms of localised compression of the brain occur and it is necessary even to modify this indication. We have already mentioned that extradural hæmorrhages in the child are rare and it not infrequently happens that a child after head injury shows signs suggesting localised pressure upon the brain. There may be an occasional twitching of one side or a squint may develop. These symptoms however pass off and the child recovers completely. It is imperative therefore not to operate unless the evidence of localised pressure upon the brain is convincing. The occurrence of the lucid interval is of very great importance in diagnosis.

**Decompression** (Fig 33) —The operation of decompression for extradural hæmorrhage is the removal of a segment of the skull without opening the dura mater. The decompression

will always be a supratentorial one, for there is no call for subtentorial decompressions in the immediate treatment of head injuries. In the great majority of cases the extradural hæmorrhage for which the decompression is performed is situated in the middle fossa, and its localisation here is

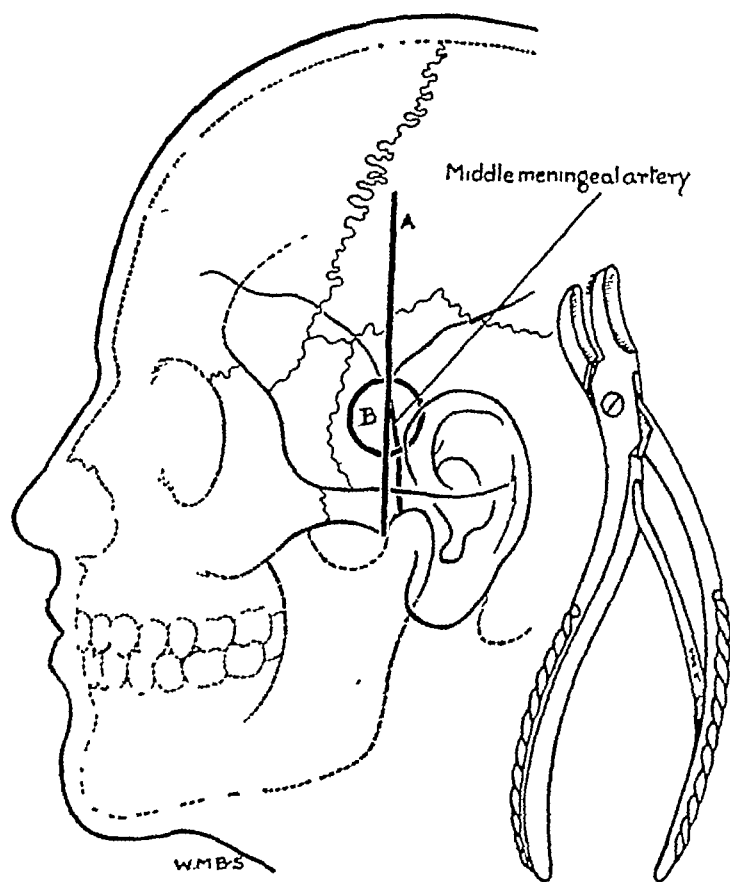


FIG 33 —INTERMUSCULO-TEMPORAL DECOMPRESSION

A, line of incision, B, situation of the trephine hole. The opening is enlarged downwards with craniectomy forceps (inset). The anterior branch of the middle meningeal artery is exposed in the hole made by the trephine.

shown by signs on the contralateral side of the body. If there is no indication of the exact situation of the extradural hæmorrhage, then a subtemporal decompression should be performed on the right side. The operation of choice is the intermusculo-temporal operation of Cushing. A vertical

incision is made through the scalp from a point above the superior temporal crest to a point immediately above the zygoma and in front of the auricle. Care should be taken not to damage the trunk of the superior temporal artery. The temporal muscle is exposed and its fascia divided in the line of incision. The fibres of the muscle are split and widely retracted so that the skull of the temporal fossa is exposed. A large trephine hole is made in the temporal fossa the point of the trephine being entered one inch behind the external angular process of the frontal bone and one inch above the zygoma. When the disc of bone is elevated the anterior branch of the middle meningeal artery will be seen unless obscured by a clot. All blood clots should be removed with forceps helped by gentle irrigation with normal saline solution. The trephine hole should be enlarged with craniectomy forceps in a downward direction as far as the floor of the middle fossa. No sharp or jagged edges of bone should be left but any such projections cut away with nibbling forceps.

Although it is popularly imagined that hemorrhage in the middle fossa is due to tearing of the middle meningeal artery this in our experience has rarely proved to be the case and the middle meningeal artery is usually intact. If however it is found at operation that the artery is injured and is still bleeding it must be ligatured. This is best done by a fine silk ligature threaded on a round bodied curved needle with which the artery is underrun. Should the artery be injured immediately after it enters the skull then it may be a very difficult matter to stop the bleeding. The foramen spinosum through which the artery enters the skull must be blocked with Horsley's wax.

No drainage tube is used and the temporal muscle is allowed to come together and the fascia covering it is held in position by a few catgut stitches and the wound in the scalp repaired.

SEPSIS AS A COMPLICATION OF FRACTURES OF THE BASE  
OF THE SKULL

Fractures of the middle fossa of the skull involving the middle ear are in effect compound fractures, and sepsis is therefore a complication to be feared. The danger is lessened if in these cases the external auditory meatus is treated as described on p 255. Under no circumstances should the ear be syringed.

Signs of infection usually appear some days after the initial injury. The temperature rises, and there is pain and tenderness over the mastoid area. The mastoid process should be opened and the dura exposed by extending the opening in the bone backwards.

## BIRTH INJURIES OF THE SKULL

**Cephalhæmatoma.**—The treatment of this injury will depend upon the size of the hæmatoma. If small, active measures are not indicated, but if large, it is better to empty it by a small incision and to bandage the head firmly so as to reduce the likelihood of recurrence.

**Cerebral Hæmorrhage.**—There has been an increasing inclination in recent years to advise operation upon all cases of cerebral hæmorrhage occurring in the newborn, for, it is argued, if such children are left untreated, although the prognosis with regard to life may be good, they always develop a mental or physical distortion, or both. The diagnosis must necessarily be one of considerable difficulty, the chief physical sign being the presence of a dark blue shadow in the anterior fontanel and absence of normal pulsation. If operation be undertaken, the anterior fontanel is exposed by raising a flap consisting of all the layers of the scalp. The dura is opened at the lateral margin of the

fontanel away from the longitudinal sinus and a piece of skull removed by means of a strong pair of scissors sufficient to expose the blood clot which is washed away with saline. The wound in the scalp is closed without drainage.

Fractures of the skull during delivery or due to the application of forceps are of course exceptional.



## CHAPTER VIII

### ACUTE DISORDERS IN THE ABDOMEN

PAIN is the chief symptom of acute conditions arising within the abdomen, and a study of its character and distribution is the main guide to formulating a diagnosis. The surgeon is denied any help from the patient in estimating the character of the pain in the case of the very young child, and for this reason the diagnosis of acute abdominal conditions is of extreme difficulty in the early stages of the illness in this class of patient. In many cases it must be limited purely to the decision as to whether or not relief may be obtained by operation. A rapid decision is of the greatest importance, for the policy of awaiting developments—in other words, of waiting until the disease has progressed sufficiently to make its nature obvious—is to be very strongly deprecated in the majority of acute abdominal conditions.

#### Character and Distribution of Pain in the Abdomen

Acute pain arising from lesions inside the abdomen may be visceral or somatic. The former is due to distension of a hollow viscus, and the latter to inflammation of the parietal peritoneum.

If the abdomen be opened under local anæsthesia, it will be noted that a very careful infiltration of the parietal peritoneum is necessary, for any sort of mechanical irritation applied to this layer, even the gentlest handling, will cause pain. On the other hand, the viscera themselves may be handled freely without producing any discomfort to the



The early complaint is thus diffuse pain of a colicky type in the centre of the abdomen—a "stomach-ache" This is followed after a varying period by peritoneal pain, localised to the right iliac fossa, and accompanied by rigidity of the overlying muscle It is due to irritation of the peritoneum by the inflamed appendix If such a sequence of events is present, the diagnosis of acute appendicitis may be made with absolute confidence

The purely obstructive lesions will not give rise to peritoneal pain until late in the course of the disease—when surgical intervention will be of little avail—and thus early local signs of tenderness and rigidity of muscle will not be present

In by far the greater number of cases of peritonitis the peritoneum is affected secondarily to a diseased viscus, and thus there will be an early history suggesting a visceral source of the infection The exception to this is in the rare cases of primary peritonitis, and peritonitis secondary to infection of the genital tract in the female child

## CHAPTER I

### INJURIES TO THE ABDOMEN

SHOCK is so marked a feature in abdominal injuries in children that it may mask the effects of a serious intra abdominal lesion. It is thus frequently impossible when the child is first seen to come to any other conclusion as to the nature of the injuries than that he has received a blow on the abdomen. This places the surgeon in somewhat of a dilemma for it may be an unwise policy to treat the shock by stimulating measures if the child is bleeding into the peritoneum. It is fortunate that in the great majority of cases in which there is nothing more serious than a contusion of the abdominal wall the patient will recover from the shock spontaneously and therefore in these cases it is a wise procedure to admit him into hospital forthwith and limit the measures to the application of warmth. It is inadvisable to give morphia even in the older child because of its tendency to mask symptoms.

#### Contusions of the Abdominal Wall

The usual result of a severe blow to the abdomen is a bruising of the abdominal muscles. The author has never seen a case either of complete rupture of the rectus abdominis or of injury to the deep epigastric artery in a young child. Should the former occur it will be necessary to suture the ruptured muscle a few days after the initial injury but should there be evidence of bleeding from the deep epigastric artery operation should be performed without delay and the artery ligated.

### **Injuries to Internal Viscera**

Apart from the physical signs of the effect of the blow itself, the symptoms due to rupture of an internal viscus will depend entirely upon the nature of its contents. The injuries may conveniently be discussed under injuries to solid viscera and injuries to hollow viscera. In the former the symptoms and signs will be due to the presence of blood in the peritoneum and the loss of blood from the general circulation. In the latter, they will be due, in the case of the intestine, to the presence of gas and intestinal fluid in the peritoneal cavity, or in the case of the bladder, to the presence of urine.

#### **SOLID VISCERA**

**The Spleen.**—Of the solid viscera, the spleen is easily the most frequently injured. The effects of injury to this organ vary considerably in individual cases, but characteristically the symptoms and signs resulting do not appear for a considerable time after the initial shock has disappeared, and in many cases the condition may not declare itself for as long as twenty-four hours after the accident. The signs and symptoms may be grouped into three sets. First of all, there will be tenderness and possibly signs of injury such as bruising over the lower ribs on the left side. There may actually be present a fracture of one or more ribs in this region, but this is a rare event in children. Secondly, there will be the physical signs caused by the presence of blood in the peritoneal cavity. Blood acts as an irritant to the sensory nerve endings in the peritoneum, so that the muscles in the left hypochondrium become rigid over an increasing area and the abdominal wall will be tender. Pain at the tip of the left shoulder is a very characteristic symptom, and may be so severe that a lesion of bone or joint is suspected. If this symptom be present after injury to the abdomen, one should not hesitate to advise

operation. As the blood leaves the spleen it tends to track downwards to the left iliac fossa and downwards and to the right along the route of the mesentery and its presence will cause an ever increasing area of dullness continuous with the splenic dullness. In view of the clotting of the blood the dullness will be fixed. Ballance's sign is not in my opinion of any value in the early diagnosis of splenic injury because it can only be present when the amount of blood lost is so excessive that the prospects of recovery are small. The sign is Fixed dullness in the left flank and shifting dullness in the right flank. The third effect is that of loss of blood from the general circulation and this may not be noticeable until a considerable quantity of blood has escaped from the spleen. The signs are increasing rapidity of the pulse rate with increasing pallor. There is restlessness and later on air hunger. One must insist however that it is unwise to wait for the onset of these symptoms of acute anæmia before making the diagnosis.

Not all cases of ruptured spleen display these typical symptoms and signs. The two chief types of case which differ in their behaviour are first that in which the spleen has been very severely lacerated and the patient dies without recovery from the initial shock and second that in which the symptoms of splenic rupture do not appear for some days possibly after the child has apparently recovered. Their onset is marked by a sudden collapse of the patient with an early appearance of general signs of bleeding. It is probable in these cases that the laceration of the spleen received at the time of injury was a small one and that bleeding into the splenic capsule has gone on slowly for the two or three days following the injury so that a large hæmatoma is formed in the spleen. This finally ruptures into the general peritoneal cavity an event which

The treatment of splenic rupture is twofold. Firstly, the bleeding must be stopped, and secondly, the volume of blood in the general circulation must be restored. As soon as the condition is diagnosed, laparotomy should be performed. It is imperative to use an incision near the mid-line, so that any associated injury, such as rupture of the bowel, may be recognised and dealt with at the same time. The incision should be a generous one and placed to the left

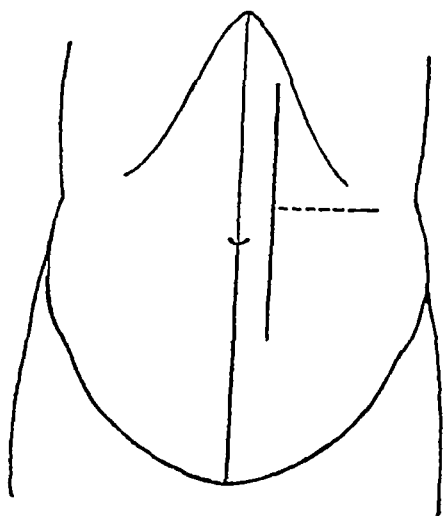


FIG 35 — INCISION FOR EXPLORING THE ABDOMEN IN CASES OF RUPTURE OF THE SPLEEN

A second incision at right-angles to the first (interrupted line) may be used should exposure be difficult

of the mid-line, commencing just below the ensiform, and passing down to a point below the umbilicus (Fig 35). On opening the peritoneum, large dark clots of blood will be found. These should be rapidly removed with the right hand while the left hand passes through towards the left hypochondrium and grasps the splenic pedicle. This hand is retained there while the rest of the clots are removed and the spleen is brought forward. This may be a matter of considerable difficulty, and in attempting

to display the spleen, the latter, already lacerated, may be further damaged. A stomach tube should be passed if the stomach is at all distended. The outer sheet of the lienorenal ligament should be divided so that the spleen may be brought forward sufficiently to enable one to see the posterior aspect of the pedicle. This should be secured by passing a stout silk suture round it by means of an aneurism needle. In these cases it is advisable not to spend an undue length of time attempting to tie the vein and artery

separately. Should there be any difficulty in obtaining a good exposure of the spleen from the paramedian incision there should be no hesitation in increasing the exposure by a transverse incision dividing the rectus muscle through a linea transversa. If all bleeding has now stopped it is not essential to remove the spleen although it is the usual custom and is probably the best thing to do if the patient's condition will stand it. The gastro-splenic omentum is rapidly divided between sutures and after division of any attachment to the colon the spleen will be fully mobilised and should be cut away distal to the ligature of the pedicle. The abdomen is repaired without drainage.

The effects of the hæmorrhage must be countered by means of a blood transfusion and it is best to do this at the time of operation commencing as soon as the splenic pedicle has been controlled. The amount of blood to be given will vary according to the size of the child and will thus probably be somewhere between 200 and 400 c.c.

**The Liver** —Rupture of the liver is happily a rare accident in children despite its size and as the child is unlikely to survive any severe injury one is concerned chiefly with minor tears. Apart from the shock due to the accident itself the symptoms and signs are produced by the leakage of blood together with a little bile into the peritoneal cavity. There will be pain and tenderness over the region of the liver and an increasing area of tenderness below it as the blood escapes into the peritoneal cavity. There may be a trace of jaundice due to absorption of bile from the peritoneum. The treatment is operative. A right paramedian incision is made and the liver explored. Whether a blood transfusion be given as in the case of rupture of the spleen will depend upon the amount of blood lost. It is very difficult to arrest bleeding from torn liver substance and one will be obliged to depend upon passing sutures of stout



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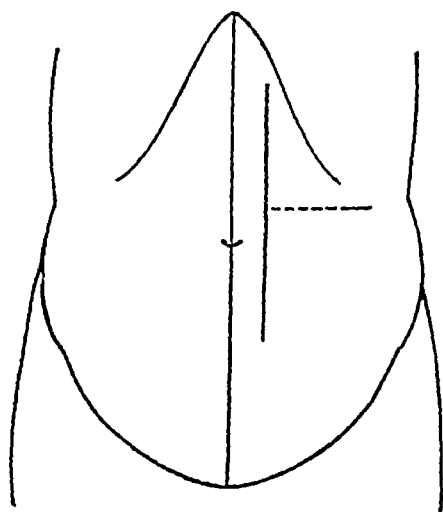


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catgut on a large round-bodied needle over the torn a commencing well to the side of the tear and passing needle, if possible, deep to the depth of the wound in liver (Fig 36)

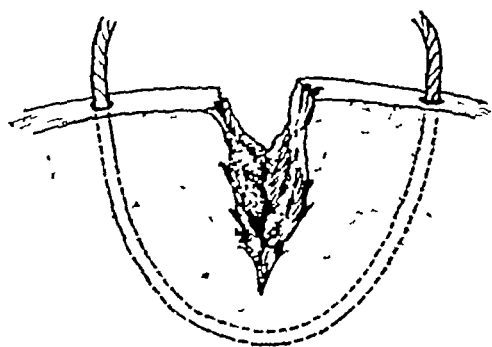


FIG 36 —REPAIR OF TORN LIVER  
SUBSTANCE

Suture passes deep to the wound

**The Kidney.**—A rupt of the kidney may v from a slight intracaps tear to extensive lac tion Cases have been ported in which the kid has been completely t from its pedicle It customary to divide r tures of the kidney i intraperitoneal and ext peritoneal, but such

classification gives undue importance to the intraperiton ruptures, which are very rare The peritoneum is in cont with the kidney for a small area on its anterior surface or and usually escapes damage

When the child has recovered from the initial sho which in cases of extensive damage to the kidney is seve the signs and symptoms of renal injury will become evide These signs and symptoms are due to the passage of ble mixed with urine into the perinephric tissues and to passage of blood down the ureter into the bladder Then turia is constant in injuries of the kidney except in the cases, invariably fatal in children, in which the kidney is t from its pedicle or in which the ureter is torn away from t renal pelvis In minor injuries, in which the capsule of t kidney is not torn at all, the only symptom will be that hæmaturia, and the treatment of all such cases is expecta Where the capsule is ruptured a swelling of increasing s will appear in the loin, with well-marked tenderness a rigidity of the overlying muscles Immediate operatio

however should not be performed unless one or both of the following factors are present

- (a) Rapid increase in size of the lumbar swelling
- (b) General signs of loss of blood

In all other cases the treatment should be expectant and operation will only be indicated at a later date in those cases in which there is persistent hematuria or in which symptoms of pain of renal origin occur and pyleography demonstrates deformity of the kidney. There is a tendency for the collection of blood and urine in the perinephric tissues to become infected during the period of convalescence from the renal injury itself and this occurrence may of its own accord give rise to a surgical emergency when the collection of fluid must be explored through a lumbar incision. The ideal procedure if this occurs is to perform a nephrectomy but in the young child such a severe operation in the presence of sepsis will rarely be tolerated and the operator must limit himself to incision and free drainage. Such an operation will inevitably lead to a urinary fistula which will necessitate a secondary nephrectomy at a later date.

In cases in which the two indications already given for urgent operation are present a nephrectomy must be performed for any attempt to suture a kidney so badly damaged as to give rise to these indications is doomed to failure. The operation should be combined with a blood transfusion. In those rare cases in which there is evidence that the peritoneum has been torn so that blood and urine are passing into the peritoneal cavity immediate operation is imperative and should be performed through an abdominal opening to the right of the mid line. Such an injury may be associated with rupture of the duodenum which is closely related to the renal pelvis on the right side. These cases in children are almost invariably fatal and it is improbable that a child so gravely injured will recover from the initial shock of the accident.



of intestinal gas. The gas will tend to accumulate in the upper part of the abdomen and will give rise to that extremely important physical sign of diminution or complete absence of liver dullness. This physical sign is of the utmost importance to the clinician and in all cases of severe abdominal injury in the child the liver area should be percussed out at intervals. The disappearance of liver dullness known to have been present when the child was admitted may be regarded as an absolute sign of rupture of one part or other of the intestinal tract. One of the first actions of a past colleague called to the roadside to examine a run-over child was to percuss out the liver dullness after which he pinned on to the clothes of the child a note reading "Liver dullness present." Such an observation made immediately after the injury may be of invaluable help to the emergency surgeon who is called upon to examine the case after its admission to hospital.

The treatment is operative. The abdomen should be explored immediately such an injury is suspected even if there is no evidence which can be regarded as conclusive. If the gut has been ruptured free air and free fluid will be noted as soon as the peritoneum is opened and a search must be made for the damaged area commencing with the terminal part of the ileum and working upwards along the gut. The ruptures may be multiple therefore one should



FIG. 37.—TRAUMATIC RUPTURE OF THE SMALL INTESTINE DUE TO A RUN OVER ACCIDENT

Segment of bowel removed from a child of eight years. Note eversion of the edges of the perforation.

in all cases examine the small intestine throughout its whole length. The rupture is likely to be on the antemesenteric aspect of the bowel, and shows as a more or less rounded opening with everted edges (Fig 37). If the hole is a small one, it may be closed by a single purse-string suture, inverting the edges. If, on the other hand, there is an irregular tear, the closing of which may lead to narrowing of the lumen of the bowel, the torn portion should be resected and a side-to-side anastomosis made.

**The Bladder.**—Ruptures of the bladder are excessively rare in children. In one recent example a tear occurred in the anterior wall of the neck of the bladder in a child of six years. The tear may involve the peritoneal surface covering the anterior wall of the bladder, or it may be confined to the extraperitoneal portion. In the one case the passage of urine into the peritoneal cavity will give rise to symptoms of peritonitis at an early date, whereas in extra-peritoneal tears the outcome will be cellulitis of the pelvic cellular tissues unless steps are taken to prevent this occurrence. In each case the bladder should be explored, and the wound repaired by interrupted sutures of catgut. The bladder should be drained through the suprapubic incision.

Rupture of the urethra, which can conveniently be mentioned now, is an even greater rarity in children than is rupture of the bladder. In all these injuries to the lower urinary tract there appears to be only one safe course for the emergency surgeon, and that is suprapubic cystotomy.

### FOREIGN BODIES IN THE ALIMENTARY TRACT

It is a rare necessity to perform a laparotomy for foreign bodies swallowed by children, for it is remarkable to what extent the alimentary tract is capable of getting rid of indigestible toys of all sizes and shapes. Even such things as open safety-pins have on occasion found their way

through the alimentary tract without untoward incident. In one of my cases a child of twelve months succeeded in ridding itself of a whistle and chain.

If the swallowing of a foreign body is suspected by the parent the child should be X rayed immediately and the position of the foreign body if shown accurately located. An X ray should be taken at intervals preferably daily so that the passage of the article may be followed. It is advisable at all events while the foreign body is seen to be in the stomach to give the child a meal of thick porridge or white bread.

What are the indications for exploration? This will depend to a certain extent upon the character of the foreign body swallowed for example in the case of an open safety pin most surgeons would probably operate at once whereas a toy soldier may be trusted to negotiate his long passage through the alimentary tract successfully. A definite indication apart from the nature of the foreign body is the onset of symptoms such as sickness. If any blood should be found in the vomit then operation should not be delayed. In addition to these two features the third indication is when X ray definitely shows that the voyage of the foreign body has been arrested for several days. Before operation the foreign body should be accurately located radiologically. If it has been arrested this will probably be either in the stomach or at the duodeno-jejunal flexure for should the article manage to escape from both of these situations then in all probability it will be passed naturally. The radiographic distinction between a foreign body in the stomach and a foreign body in the third part of the duodenum is one of considerable difficulty and cases have occurred in which the stomach has been opened on a faulty radiological diagnosis and the foreign body has not been found. The child should be carefully screened therefore in the antero-posterior and oblique positions so that such an unfortunate



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error may be avoided. It is wise in all cases to have an X-ray taken *immediately* before the operation. If facilities allow, of course, the ideal of operating on an X-ray table should be followed, but as a general rule this is not practicable.

The incision should be made to the left of the mid-line above the umbilicus, and the stomach carefully felt. The foreign body should be brought up underneath the anterior wall of the stomach and a small incision made over it of length sufficient for its extraction. A pair of gall-stone forceps may be helpful for this purpose. Occasionally, when the child is recumbent during the operation, the foreign body may become lodged in the cardiac end of the stomach immediately underneath the diaphragm, and can only be felt by opening the stomach and introducing a finger. In the case of a pin or a needle, it may be possible to effect the removal without incising the stomach by forcing the sharp end through the stomach wall and extracting it with the fingers.

Should the foreign body be located in the third part of the duodenum, near the flexure, the operation is a very difficult one, especially in the small child. If the stomach is distended, it should be relieved by the passage of a stomach tube. The transverse colon must be lifted out of the wound and turned over to the left and a vertical incision made, carefully avoiding the left colic artery. The lesser sac is thus exposed, and the third part of the duodenum will be identified lying behind the peritoneum of the posterior abdominal wall.

## CHAPTER X

### INFLAMMATORY CONDITIONS IN THE ABDOMEN

#### I. ACUTE APPENDICITIS

THAT the great majority of cases of acute appendicitis in children have already perforated before operation is performed is something of a reproach to the medical profession. It cannot be held entirely to blame however for this very undesirable state of affairs for the latter is very largely contributed to by three factors

- (a) The difficulty of diagnosis in the early stage of the disease.
- (b) The rapidity of progress of the changes which cause perforation
- (c) The administration of a purgative by the mother

These factors are more than ever true in the case of the very young child in whom the mortality on account of delayed operation is higher than in older children and adults

One of the pitfalls offered to the unwary is the complete cessation of symptoms which marks the bursting of the tense appendix into the abdominal cavity. Frequently after this event the relief to the child is so great that a complete change occurs transforming him from a fretful crying child into a placid and uncomplaining one and for the time being those in charge are lulled into a sense of false security

The following case well illustrates the force of the foregoing remarks

A boy of three and a half years reached Newhaven from Paris at 2 a.m. on a Sunday morning having slept during the crossing. In the train he complained of pain in the

stomach, and was sick. He became more and more fretful, and on reaching home he was given a teaspoonful of castor oil. The pain increased in severity, and the child had no sleep that night beyond an occasional doze. He was seen by his doctor at 10 a.m. on Sunday morning, and appendicitis was suspected. When seen at 1 p.m., the child was lying on his side with his knees drawn up, and resisted all attempts at examination. A small dose of chloral was given, and the child seen again two hours later. He was then quieter, and could be examined more easily. There was tenderness on deep pressure in the right iliac fossa, but no involuntary rigidity could be detected. Operation was advised and the patient transferred to a nursing home. On his arrival there he was transformed. His colour had returned, and he sat up in bed, happy and talkative. At operation (7 p.m.) a perforated gangrenous appendix was removed. The perforation had occurred during the journey to the nursing home.

Such a history is not an isolated example, but is typical of the condition, and occurs again and again in both hospital and private practice.

### **Pathology**

The greater number of cases of acute appendicitis in children appear to be of the obstructive as opposed to the catarrhal type, but, although in adults it is possible in many cases to distinguish between the two before operation, it is not so in the young child. The distinction, however, is of no practical value, for it does not influence treatment.

Reference has been made to the extraordinary rapidity with which pathological changes leading to perforation occur. Although in these cases the whole appendix may be gangrenous, it is more usual to find that the gangrene is limited to a small area of the appendix wall, frequently near the tip and corresponding to the limit of attachment of the

meso-appendix (Fig 38) In the fulminating cases most typical of the very young child perforation occurs before protective adhesions have had time to form and isolate the inflamed focus and the pus pours out freely into the general peritoneal cavity In less acute cases chiefly in older children the great omentum and neighbouring coils of small intestine have become glued together to shut off the appendix from the general peritoneal cavity before perforation occurs so that when the latter takes place a localised abscess is formed

Children especially younger children have far less natural capacity than adults to resist intra abdominal infection and none but the very mildest attack of acute appendicitis is likely to resolve spontaneously

### Clinical Aspect

**The Phase of Onset.**—Pain is the predominant feature It is usually of sudden onset although in some cases there will be a history of occasional mild attacks of stomach ache and perhaps constipation In the beginning of the attack the pain is centred around the umbilicus and is due to the violent contraction of the muscular coats of

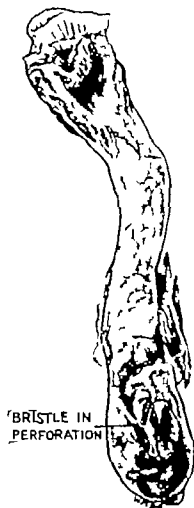


FIG 38 — APPENDIX REMOVED FROM A CHILD OF EIGHT YEARS

The proximal three fourths is only slightly inflamed but the distal fourth is gangrenous and has perforated at the point where the mesentery terminates

the appendix in response to the tension within the latter of inflammatory exudates, intensified in many cases by the presence of a concretion. The pain is of the colicky type, varying in intensity from time to time, but the completely quiescent intervals characteristic of acute intussusception do not occur. Nor does the pain commence with the agonising suddenness of the latter condition, but steadily increases to a climax from a comparatively gentle beginning. The child complains of a feeling of sickness and may actually vomit once or twice. Vomiting, however, is rarely a marked feature of the disease. During this stage there are no physical signs in the abdomen, and the medical attendant has no guide other than the intensity of the pain to help him to distinguish between colic due to mechanical irritation of the intestine, and a serious lesion demanding surgical aid. It is during these early manifestations of the disease that the child runs the grave risk of being made to take castor oil. This in most cases is the mother's doing, but too frequently the responsibility is the doctor's. There is abundant proof that violent purgatives are instrumental in precipitating perforation of the inflamed appendix, and they are therefore to be rigidly avoided.

**The Peritoneal Phase.**—In a typical case the pain alters in character and situation after a varying period. The pain is now of the somatic type and differs from the pain of onset—visceral pain—in three particulars

- (a) It is localised
- (b) It is constant
- (c) It is accompanied by physical signs

If the inflamed appendix lies in close relation with the parietal peritoneum, the latter becomes involved in the inflammatory reaction after a lapse of time depending for its length upon the acuteness of the infection. Thus pain will be felt in the right iliac fossa

The patient will place his hand on the abdominal wall somewhere between the umbilicus and the anterior superior spine the exact localisation varying with the position of the appendix. Movement aggravates the pain so that the patient will lie still probably with the hips flexed to relax the abdominal wall. This restfulness is in marked contrast to the restlessness so characteristic during the central abdominal pain of the onset.

The physical signs are tenderness to pressure and rigidity of the overlying muscle. Hyperæsthesia and hyperalgesia are clearly of little value except possibly in older children.

The maximum point of tenderness will naturally vary considerably with the exact position of the appendix. In the majority of cases it lies in the neighbourhood of McBurney's point—the junction of the middle and outer thirds of the anterior spino-umbilical line. In the very young child in whom the cæcum may not be fully descended the area of maximum tenderness may be considerably nearer the costal margin.

Extreme pain may be elicited in some cases by the slightest pressure so that very great gentleness in palpation is required. On the other hand heavy palpation in the right iliac fossa is likely to cause pain in the young child even in the absence of any disease and one must therefore be cautious in accepting such evidence before making a comparison by palpating the left iliac fossa with equal pressure.

In the less acute cases in older children as in adults the pain may be accentuated when the pressure of the hand on the abdominal wall is suddenly released.

Rectal examination is an essential procedure in the majority of cases. This qualification is made advisedly for when the case presents all the typical manifestations so that there can be no room for doubt as to the diagnosis and the position of the appendix rectal examination is not likely to



add anything of value, and one is needlessly adding to the burden of the patient by its performance. In all cases where doubt exists, however, it must be made. A small finger cot should be used, and the whole procedure carried out with the utmost gentleness. In the very small child the finger will reach to the lower part of the iliac fossa, and any swelling due to inflammation or any tenderness (making the patient suddenly cry or attempt to move away) will be noted. If the appendix is overhanging the brim of the pelvis, a definite œdematous swelling, extremely tender on slight pressure, will be noted, and the diagnosis made or confirmed thereby. When no definite swelling can be felt, a comparison between bimanual palpation of both iliac fossæ may be helpful in determining the presence of an inflammatory focus.

#### GENERAL FACTORS

The temperature is raised to 99° or 100° in the older child, but in the very young may reach a much higher level. No great dependence must be placed upon it, however, as a means of differential diagnosis, for in the young child the temperature is liable to be raised as a result of any intra-abdominal disorder. The bowels are usually constipated, though they may have acted normally up to the day of onset.

The older child will complain of nausea, while in the young infant there will be a distaste for food. The tongue is furred, and the breath may have a characteristic smell, difficult to describe, but vaguely reminiscent of that of a *Bacillus coli* abscess.

At this stage the dawn of the abdominal or Hippocratic facies may be just discernible, the most noticeable feature being a slightly anxious expression. At a later stage the abdominal facies becomes so characteristic that a diagnosis of peritonitis may be made at sight.

An examination of the white cells of the blood has not been in our experience of any real value in the diagnosis of the disease in its early stages as we have found no characteristic picture represented. The urine will frequently be loaded with acetone bodies particularly in the young child but will show no other abnormality.

#### THE SIGNIFICANCE OF THE POSITION OF THE APPENDIX

Thus far we have considered only the typical case with the appendix lying in close relation to the anterior abdominal wall in the right iliac fossa. In cases in which the appendix is long and hangs down into the pelvis the physical signs of tenderness and rigidity in the right iliac fossa may not be very marked. This however is fully compensated for by the ease with which the appendix can be felt by rectal examination. There may also be frequency of micturition.

In cases of incomplete rotation of the cæcum the appendix may lie close to the liver and reference has already been made to the situation of the physical signs in such cases. In one of my patients the appendix was found in the left hypochondrium. This was not due to non rotation of the cæcum but to an excessively mobile ascending colon and hepatic flexure. Rarely cases of complete transposition of the viscera are met with in which the cæcum and appendix are in the left iliac fossa.

The greatest difficulty exists when the appendix passes up behind the ascending colon—the so-called retro-cæcal appendix. This arises from the fact that the sensitive parietal peritoneum of the anterior abdominal wall is protected from the inflamed appendix by the interposed bowel and the clinician is not presented with the two physical signs of tenderness and rigidity in the right iliac fossa upon which the diagnosis in a typical case is based.

In a few cases the appendix is para-colic rather than

retro-colic, passing up on the outer side of the ascending colon. In these there will be tenderness in the flank between the iliac crest and the last rib. When the appendix is truly covered by the colon there may be, however, a complete absence of the "peritoneal phase" of the disease as described above. It is true that tenderness may be elicited by very firm palpation, but this physical sign, especially in younger children, cannot be relied upon to any extent. The most helpful physical sign in retro-cæcal appendicitis is that of

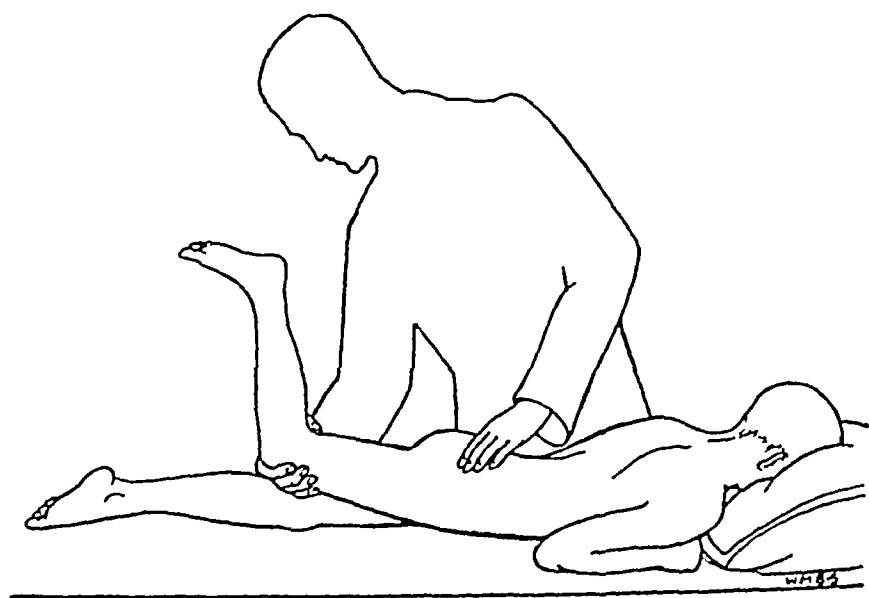


FIG 39 —THE PSOAS FLEXION TEST IN ACUTE APPENDICITIS  
(For description see text)

psoas spasm. The inflamed appendix lies upon the psoas sheath—at operation it may be found lying in an oedematous furrow on the surface of the muscle—and in consequence the muscle is thrown into spasm with resulting flexion of the hip-joint. This may be so marked that the child holds the joint in a position of  $90^{\circ}$  of flexion, so that inflammation of the hip-joint itself may be suspected. In less marked cases the physical sign is a resistance to extension rather than a fixed flexion of the joint. The sign is elicited by placing the

child in the prone position the *left* leg is held just above the knee and the hip-joint extended. The *right* leg is now manipulated in the same way and the difference between the mobility of the joints when the sign is positive will be readily appreciated (Fig. 39).

**The Phase of Complications.**—In fulminating cases especially in the very young child perforation of the inflamed appendix may occur within eighteen to twenty four hours after the onset of the disease and the peritoneal phase may be of very short duration. Whether perforation leads to localised abscess or to general peritonitis will depend upon whether or not the appendix area has been shut off by inflammatory adhesions which in turn depends upon the virulence of the infection and the powers of resistance of the patient. The younger the child the less able is he to form protective adhesions so that perforation into the general cavity of the peritoneum is the general rule whereas a localised abscess is a more frequent finding in older children. In retro-cæcal cases perforation into the peritoneal cavity cannot readily occur and it is thus usually followed by a localised collection of pus.

#### APPENDIX ABSCESS

The situation of an abscess is entirely dependent upon the original situation of the appendix. The abscess may thus collect

- (a) In the right iliac fossa
- (b) In the pelvis
- (c) Behind the colon

A collection of pus underneath the diaphragm (sub-phrenic abscess) is of rare occurrence in childhood not a single case being recorded during the past twenty years in the Evelina Hospital. The only probable origin in children is the appendix and the routine use of Fowler's position is

largely responsible for the elimination of this complication.

When an abscess has formed, a lump will be palpable. If small, there may be some difficulty in feeling this if it is in the right iliac fossa owing to the boarding of the muscles, but a retro-colic abscess is readily felt if two hands be used after the manner adopted for examining a kidney, and in pelvic abscess the mass will be felt on rectal examination. The constitutional changes will be far more marked than in the pre-perforation phase. The temperature will be consistently high, the face flushed, and the skin dry. Sickness may be a more marked feature, and the blood count will show a definite leucocytosis—occasionally 30-40,000 per c mm. The abdominal facies—except in retro-colic cases—may be a definite feature, especially if the abscess has been present for some time and is a large one. Pelvic and retro-colic abscesses may present features which call for special comment.

*Pelvic Abscess*—In cases where the abscess is of large size, a swelling will be felt in the hypogastrium, and, as a rule, there is well-defined oedema of the subcutaneous tissues in the pubic and suprapubic regions. In less marked cases the abscess may be felt only on rectal examination. The presence of pus in the pelvis is frequently attended by frequency of micturition and tenesmus or actual diarrhoea. These two symptoms are characteristic of the formation of a pelvic abscess following the removal of a gangrenous appendix.

*Retro-Colic Abscess*—In these cases the abscess lies in the retro-peritoneal cellular tissue behind the ascending colon. One of the most striking features of the condition is the mildness of the accompanying physical signs. There is little or no rigidity of the overlying muscles of the abdominal wall, and there may be very little tenderness. Owing to the absence of muscular rigidity, it is possible to feel the abscess

mass without difficulty. The most marked physical sign is that of flexion of the right hip and the condition may simulate a joint infection. The following case illustrates this point.

John R. aged six hurt the right hip when taking part in a wheelbarrow race. Two weeks later he commenced to limp and the right hip became flexed. When first seen four weeks after the onset the right hip was flexed to an angle of  $90^{\circ}$ . The flexion was not correctable and all movements were limited. No other signs of hip-joint infection were present. The temperature was  $101.6^{\circ}$ . There had been no vomiting but the bowels were constipated. Abdominal examination was incomplete owing to the position of the hip but there was no rigidity in the right iliac fossa. There was a leucocytosis of 29,200 of which 89 per cent were polymorphonuclears. An extension was applied to the right leg and the flexion was reduced in two days to about  $10^{\circ}$ . The white count was now 15,400. A well defined tender mass could now be felt high up in the right iliac fossa. At operation a partly gangrenous appendix was found lying in an abscess cavity which appeared to burrow into the psoas muscle. The appendix was removed and the wound drained through a second incision in the loin.

The abscess in retro-colic cases does not as a rule grow to the enormous size that is sometimes met with in neglected cases of pelvic abscess but on occasion it is sufficiently large to produce the bulging in the posterior aspect of the loin so characteristic of a perinephric collection with slight œdema of the overlying skin. Such a bulge is best appreciated by sitting the child up and examining the back from above so that any asymmetry of the loins may be detected by comparison of the two sides viewed together from the same angle (Fig. 79).

#### GENERAL PERITONITIS

Reference has already been made to the apparent improvement in the condition of the child which may occur immediately following the perforation of a distended appendix

into the general peritoneal cavity. If the surgeon sees the child for the first time during this period of quiescence, he may mentally accuse the parents of exaggerating the symptoms exhibited by the child before the perforation occurred, for there may be at this stage no physical signs commensurable with the very serious state of affairs inside the abdomen. Such a quiescent period is, however, of short duration, and pain, now diffuse, returns. The temperature rises, the abdomen ceases to move freely on respiration, and the muscles of the lower abdomen become rigid. Vomiting becomes a marked feature, the abdomen gradually becomes distended, and constipation is absolute. The abdominal facies develops and completes a very characteristic clinical picture.

### Diagnosis of Acute Appendicitis

In the very young child the diagnosis may be of exceptional difficulty. No history is obtainable, and the fretful patient will not permit a lengthy and deliberate examination of the abdomen. The importance of the character and severity of the pain cannot be overstated in such cases, and the clinician must be able to appreciate the severity of the pain from the behaviour of the child. The late Sir Watson Cheyne's dictum in regard to acute appendicitis is one to follow—always operate if the pain is severe.

It is of little practical value to enumerate other acute conditions in the abdomen which demand urgent surgical treatment in discussing the differential diagnosis, and the question may thus be limited to those non-surgical conditions which on occasion may give rise to thoughts of acute appendicitis.

First in importance	acute conditions	acting the
base of the right lobe	ura. In	stages of
acute pleuro-pneumonia	in may	to the
right side of the a	may b	ed by

rigidity of the muscles of the abdominal wall. These physical signs and symptoms result from the fact that the lower intercostal nerves which supply the skin and muscles of the anterior abdominal wall also supply sensory branches to the parietal pleura in the neighbourhood of the diaphragm.

Error in diagnosis due to this cause will be avoided by thorough clinical examination. It has been our experience that should the clinical findings create doubt as to whether the lesion is below or above the diaphragm it is far more likely to be above. In any case should the reverse hold true the appendicitis will not be of the fulminating type and operation can safely be deferred until the diagnosis is more apparent. In short a waiting policy is for once the wiser course.

Acute right sided pyelitis is a condition constantly to be borne in mind if the symptoms and signs are in the least part atypical of appendicitis. An examination of the urine will in all cases be a routine in any acute abdominal condition so that the mistake should not occur. If the faintest haze of albumen is found microscopic examination of a drop of the fluid must be made and the presence or absence of white cells noted. From the clinical standpoint the main differences between acute pyelitis and acute appendicitis are as follows.

Pyelitis is accompanied by a high temperature (sometimes 103° to 105°) at the onset and there is frequently a rigor. The pain is not referred to the umbilicus and is not of the colicky type. There is an absence of true muscular rigidity and tenderness if present is to be found posteriorly at the angle between the twelfth rib and the erector spinæ.

### **Treatment**

The treatment of acute appendicitis is appendicectomy. The only exception to this rule is in cases of appendix abscess in which it is sometimes a sound policy to limit the



immediate operation to drainage of the abscess, the appendix being removed at a later date

The problem to be discussed from the surgical standpoint is chiefly confined to the method of approach. The incision to be employed must obey two conditions:

- (a) It must allow of adequate exposure without the need for heavy retraction
- (b) It must be suitable to allow of adequate drainage

In uncomplicated cases in which the position of the appendix can be determined before operation, McBurney's muscle split incision, or a modification, is undoubtedly the ideal method. The author has had more than one occasion, however, to regret having used this incision. It is, for example, not always possible in the young child to be certain before operation whether or not perforation, for which drainage will be certainly needed, has occurred. Furthermore, especially in the young infant, it will be more profitable if one always plans the operation with a view to drainage, for should the slightest doubt exist in the mind of the operator as to whether drainage should be used, he will be wise to employ it. Drainage is thus advocated in the very acute cases in which there is a little free fluid in the peritoneal cavity and plastic lymph around the appendix bed, even if the appendix has not actually perforated. Furthermore, although it is possible to enlarge a muscle split incision by division of the rectus sheath, the method is not a desirable one from the standpoint of obtaining a good scar. For these reasons it is wiser to make the incision just to the right of the mid-line, displacing the rectus muscle outwards.

**Steps of Operation.**—The ascending colon and cecum are recognised by their situation and by the anterior longitudinal muscle band. Before any effort is made to deliver the appendix, the rest of the peritoneal cavity must be very carefully shut off by large swabs wrung out in hot saline.

for there is always a danger of rupturing the distended appendix during its removal. Except in retro-cæcal cases the appendix is not as a rule difficult to expose. Gentle traction may be applied by means of a Spencer Wells forceps clamped to the meso-appendix near its distal end. If the meso-appendix is shortened and prevents delivery of the appendix and cæcum it can usually be freed sufficiently by dividing the peritoneum (but not the fat) covering its outer



FIG 40—FREEING THE APPENDIX BY DIVISION OF THE PERITONEUM ALONG ITS LATERAL MARGIN

(or cæcal) surface with a few gentle touches of the knife (Fig 40)

Extensive mobilisation of the cæcum should be avoided as this manipulation leaves an unperitonised area of considerable extent which is susceptible to infection. In children such mobilisation is fortunately rarely needed and adequate exposure of the cæcum is obtainable without it.

The meso-appendix is now divided. If it is thickened by oedema it must be divided after clamping with artery forceps in short segments three or four forceps being used. To take a large portion of the meso-appendix in the bite of the

Spencer Wells is to invite trouble when the ligature is to be tied (Fig 41, A)

If there is no œdema, and the appendicular artery can be seen, it is better to tie the latter before it has branched, using an aneurism needle (Fig 41, B)

The purse-string suture is of No 0 catgut on a straight intestinal needle. It should catch up the longitudinal muscle bands, and is placed  $\frac{1}{2}$  inch from the root of the

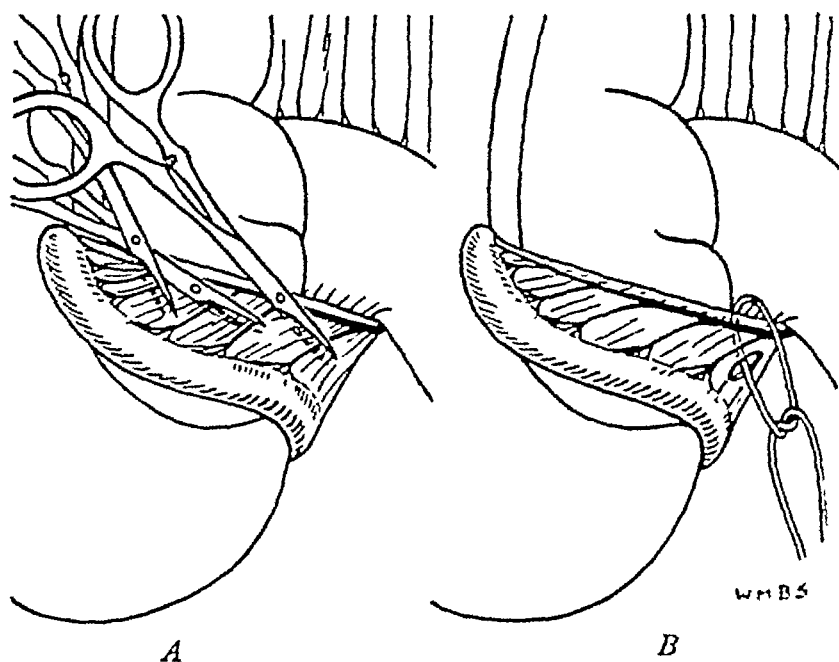


FIG 41.—METHODS OF DEALING WITH THE VESSELS IN THE MESO-APPENDIX

(For description see text)

appendix. It should be tied loosely in a single knot before amputation of the appendix.

Halsted's three clip method of amputating the appendix is a rapid and efficient one (Fig 42). A ligature of No 1 catgut is applied after removal of the first artery clip and the appendix divided by a carbolic knife through the crushed area after removal of the second clip, the rest of the cecum being isolated by means of two small swabs. The burial of

the appendix stump is better controlled if done by the operator rather than his assistant. The latter holds firm one end of the previously loosely knotted purse-string stitch. With the left hand the operator takes the other end and with his right inverts the stump with a blunt instrument.

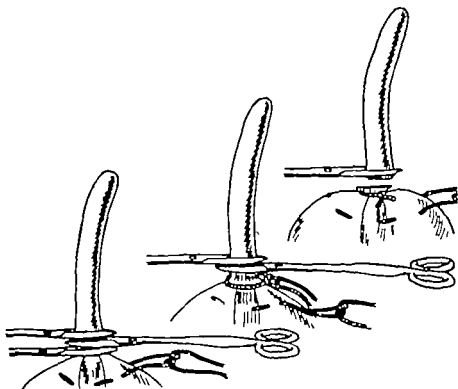


FIG. 42.—THE THREE CLIP METHOD OF AMPUTATING THE APPENDIX.

closing the purse string by pulling on his end against the resistance by the assistant (Fig. 43).

#### OPERATIVE PROCEDURE WHEN AN ABSCESS IS PRESENT

In cases in which an abscess is present the rule to be obeyed is to *cut down over the centre of the abscess*. This rule should be absolute. It is clearly bad surgery to make a para median incision to expose an abscess in the right iliac fossa for unaffected areas of the peritoneum will be exposed



should not be stitched firmly against the drainage tubes but an appreciable interval must be left

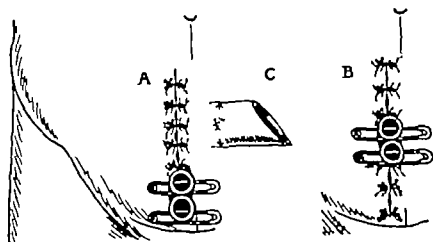


FIG 45—DRAINAGE OF AN APPENDIX ABSCESS

- (A) Correct method the tubes being placed against the lower angle of the incision  
 (B) Incorrect method Pus is liable to pocket between the tubes and the lower angle of the incision  
 (C) Drainage tube used actual size

Finally the skin edges are brought together by a few interrupted stitches of silkworm gut the skin-everting stitch first suggested by Mr Arthur Edmunds is excellent for this purpose (Fig 46)



FIG 46—THE EDMUNDS SKIN EVERTING SUTURE

The needle is passed deeply half an inch from the wound and is then brought back through the edges so that these are everted and brought into close apposition

**Excision of Abscess**—It occasionally happens that a small abscess is found surrounding a perforation near the tip of the

appendix, the wall being formed by the great omentum. The whole abscess cavity is comparatively free from adhesions. No attempt is made to open the cavity, but the appendix and abscess cavity are removed *in toto*. The first step in this procedure is to divide the omentum between ligatures a short distance away from the inflammatory mass (Fig 47).

It is a safe technique to perform this step by means of a double aneurism needle rather than by division between

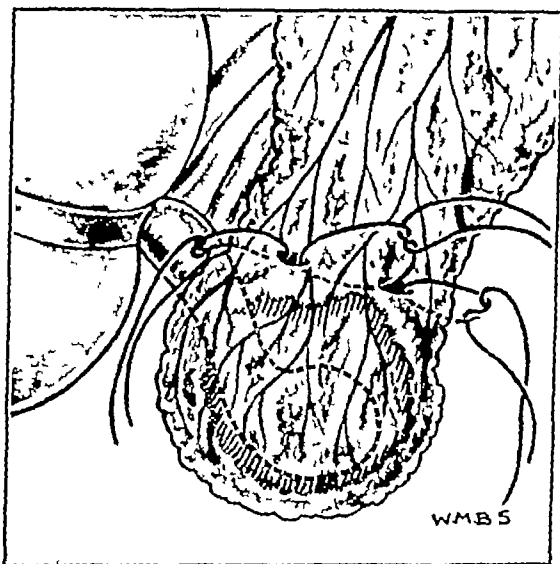


FIG 47 —EXCISION OF A SMALL APPENDIX ABSCESS

The omentum is tied off a little distance from the inflamed area

Spencer Wells. Drainage should be employed, a single tube reaching down to the bed of the appendix being adequate.

If pus is lying free in the peritoneal cavity, the appendix must be removed and the abdomen drained. One drainage tube should be placed so that it leads down to the bed of the appendix, and a second, which should be of larger size, is placed right down into the pouch of Douglas (Fig 48). The greatest importance attaches to the accurate placing of these tubes. No lateral holes should be cut for fear of a portion of small bowel becoming lodged in them.

### Management after Operation

The child is nursed in Fowler's position (Fig 48). If it is a clean case the patient may be allowed to take fluid as soon as he feels inclined and may return to a light diet on the second or third day. An enema is given on the second day and a mild saline purge. Fowler's position may be

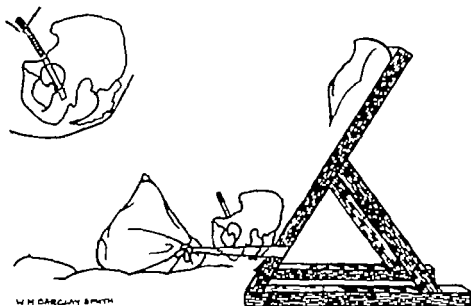


FIG 48 —FOWLER'S POSITION

Note the relation of the drainage tube to the bony pelvis

abandoned on the second day and the patient allowed to lie as he wishes.

If drainage has been used in a case in which there has been no perforation Fowler's position should be adopted until the tube is removed. There should be no hurry to do this. It is best to wait until the tube is pushed out by the intestines it being shortened each day and at the same time rotated to prevent it being glued to the abdominal viscera.

When a tube is *in situ* strict precaution against secondary infection must be taken. The dressing should be volu



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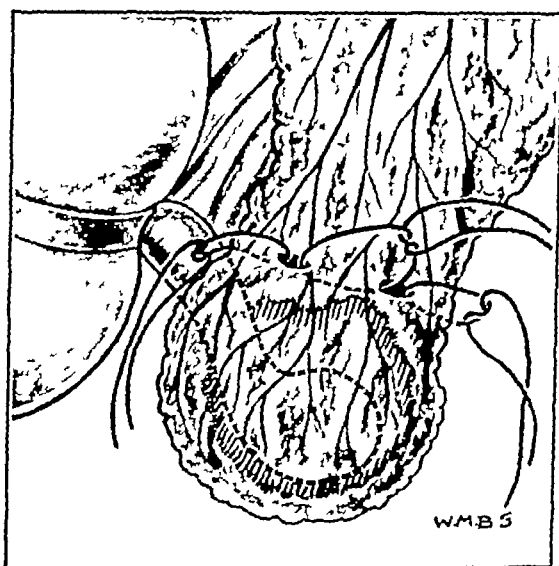


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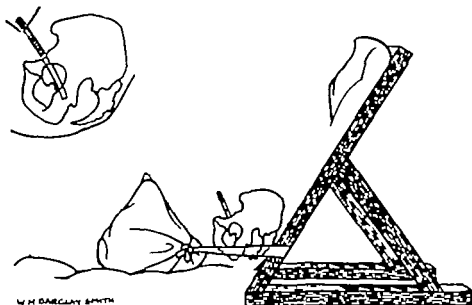


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When a tube is *in situ* strict precaution against secondary infection must be taken. The dressing should be volu

minous, and if there is any discharge, the dressing should be wrung out in an antiseptic such as 1 in 40 carbolic so as to form an effective barrier against infection from without is created. Gloves should be worn by the attendant when the dressing is done.

If there is a localised abscess, an antiseptic dressing should be employed from the start. In these cases purgatives should be best avoided, the lower bowel being emptied by an enema on alternate days. Care must be taken that the tubes are not removed prematurely.

When peritonitis is present, the post-operative care is fraught with anxiety. There is no condition in the world of abdominal surgery which makes a greater demand upon the skill of the medical attendant. Rule of thumb methods cannot be obeyed, for each case must be dealt with on its own particular merits. Guiding principles are

- (a) To administer fluids freely
- (b) To rest the bowel
- (c) To avoid wearying the patient by frequent dressing

In all but very young children, continuous rectal saline should be given. If the child is very ill, saline may be given continuously by the intravenous method (see Peritonitis, p. 141). The mouth should be kept clean and moist, and the child should only be permitted occasional sips of water.

Purgatives must be avoided. In older children morphine should be given so that rest is assured and pain minimised.

### **Post-Operative Complications**

Complications after operation are practically limited to those cases in which the appendix has perforated into the peritoneal cavity before operation. In cases of localised abscess the only real danger lies in too early removal of the tubes, so that a residual abscess forms. Frequently,

cases in which the appendix was not removed at operation there is considerable delay in the healing of the sinus but in the child this is of no very great importance

In peritonitis cases the most dreaded complication is that of *ileus* due to spread of infection in the peritoneal cavity. The symptoms of this condition do not appear as a rule until three or four days after the operation. The condition is one in which the bowel becomes completely paralysed and in the fully developed state is associated with a profound toxæmia and the prognosis is extremely grave.

Before such an extreme is reached the patient passes through a stage of threatened ileus. Its onset is marked by increasing abdominal distension with vomiting and abdominal pain. The child becomes restless and the expression anxious. Little or nothing is passed by the bowel. The two important factors in the treatment of the condition are (a) repeated washing out of the stomach (b) continuous subcutaneous or intravenous normal saline. No purgative or bowel stimulant should be given. I have frequently used *Bacillus Welchii* serum for this condition (see Peritonitis) but am still doubtful as to its value.

Jejunostomy for ileus in children is not recommended except as a last resort.

*Fæcal fistula* may occur during the stage of threatened ileus. If so it is a welcome event and may mark the turning point of the illness. Fæcal fistula may however occur apart from threatened ileus and as a direct result of localised gangrene of the cæcal wall in the neighbourhood of the appendix. It is not of serious consequence and almost invariably closes spontaneously. It frequently happens that the discharge from an appendix wound is so foul that a fæcal fistula is suspected where none exists.

*Secondary abscess* may form during the second week. This is due either to inadequate drainage or failure to drain

at all, to premature removal of the tubes; or to spread of the infection. In cases nursed in Fowler's position the common situation for such a secondary abscess is in the pouch of Douglas. Clinically, its presence is suggested by a continued rise in temperature, frequency of micturition, and diarrhoea or tenesmus. It should be drained as soon as its presence is detected. This is done in most cases through the original mid-line incision, a drainage tube being passed into the abscess cavity with a minimum of disturbance. Great care must be exercised not to open up the general peritoneal cavity, which at this stage of the illness will be well shut off from the infected area.

If the abscess forms a marked bulge which can readily be felt on rectal examination, drainage may be achieved by passing a blunt instrument into the cavity of the abscess from the rectum. Although this method works extremely well, and is the natural method of drainage, it must not be attempted unless the operator is absolutely certain, without any shadow of doubt, that the lump to be felt per rectum is an abscess and not a mass formed by matted and adherent coils of small intestine.

*Cellulitis* of the abdominal wall is fortunately a very rare complication, and will not occur if drainage is adequate.

*Mechanical obstruction* to the bowel may occur at any time after the first week, and it may be extremely difficult to decide whether the effects of such an obstruction are due to an organic cause, such as a band of granulation tissue, or to paralysis of the bowel. If the obstruction is due to a band, that is to say a newly formed mass of fibrous tissue, it usually occurs suddenly, sometimes when the convalescence is otherwise satisfactory, and it has not the steady progress of a threatened ileus. The symptoms are those of acute obstruction, and there must be no hesitation in exploring the abdomen for the cause. Rarely strangulation of a loop of the bowel may occur as a result of new formation of fibrous

tissue in the peritoneal cavity. In such an event the symptoms are of very sudden onset and immediate operation must be undertaken.

## II. PERITONITIS

The most common source of infection of the peritoneum in children is the inflamed appendix in which case the peritonitis is of the *Bacillus coli* type. Acute cholecystitis and perforation of gastric ulcer are practically unknown in childhood and as a source of peritoneal infection can be ignored. Peritonitis may be a terminal event in conditions in which there is strangulation of the gut wall and consequent perforation such as may occur in volvulus and intussusception but peritonitis secondary to these conditions is of little interest to the surgeon for by the time this has occurred little can be done for the patient. Occasionally rupture of an acutely inflamed lymphatic gland may cause peritonitis and a further equally rare cause is the perforation of a typhoid ulcer. Although tuberculous peritonitis is comparatively common in children it is only of importance from the emergency standpoint by reason of the complications that may occur. The sources of infection in peritonitis however are not confined to organs inside the abdomen but the infection may spread from elsewhere. Such may be the case in pneumococcal and streptococcal peritonitis in which the organism may reach the peritoneum via the blood stream or in the female child via the Fallopian tubes.

### THE BEHAVIOUR OF THE PERITONEUM IN INFECTION

The peritoneum possesses an inherent capacity to resist infection and in mild cases it is able to overcome it either by subjugating it entirely or by shutting it off so that a localised abscess is formed. This power of defence against

infection is not so well developed in the child as in the adult, so that less reliance must be placed upon it. In cases of appendicitis in the young child, therefore, operation should be performed at whatever stage the disease has reached when first seen. Advantage of this capacity of the peritoneum should be taken, however, in milder cases of peritonitis in which the infection comes from outside the abdominal cavity. This applies particularly to milder cases of pneumococcal infection, and operation should be postponed until the peritoneum has been given an opportunity to localise the infection, so presenting an abscess for the surgeon to drain. The virulence of the infecting organism is naturally a deciding factor, and in fulminating cases of infection the peritoneum is powerless to put up effective barriers against its spread. Anatomical factors influence the process to a certain extent. The peritoneum lining the pelvis, for example, appears to be not only less sensitive, but to have greater powers of resistance than the peritoneum of the upper abdomen. Hence pelvic peritonitis has less terrors than peritonitis, say, of the subhepatic and perirenal pouches. Upon this fact the rationale of Fowler's position largely depends.

*Absorption*—One of the main clinical features of peritonitis is the toxæmia. This, obviously, will vary in degree according to the type of infecting organism and to the surface area of peritoneum it involves. It may vary from the slighter constitutional disturbances of the small localised abscess to the extreme prostration which accompanies diffuse peritonitis. Absorption of the products of bacterial infection is carried out at a very rapid pace, though the actual mechanism of the process is little understood. The presence of a large quantity of pus inside the abdomen will eventually lead to paralytic ileus, and this condition is inseparable from that of acute peritonitis. It is, in fact, the prevention of paralytic ileus, which is almost invariably fatal in children,

that forms the basis of the treatment of acute peritonitis. The paralysis may to some extent be due to the direct action of pus upon the walls of the intestine but this action probably plays only a minor rôle for it seems certain that widespread paralysis of the bowel is due mainly to the action of the toxæmia upon the autonomic ganglia themselves. The truth of this is illustrated by the occasional occurrence of ileus after abdominal operations in the absence of sepsis. Furthermore Alvarez\* has shown that a portion of intestinal muscle removed in ileus is still capable of contraction outside the body.

### Clinical Aspect

The clinical aspect of peritonitis gives a characteristic picture irrespective of the type and source of the infection although pneumococcal and streptococcal cases present certain differences and peculiarities which will necessitate a separate description.

Pain is intense and constant and situated as a rule over the lower abdomen. The muscles are held in contraction so that the abdomen is retracted and does not move on respiration. They are rigid to the touch, the rigidity being greatest where the infection is most intense. There is tenderness to the slightest pressure and hyperæsthesia may be so marked that the touch of the lightest bedclothes is resented. Vomiting is frequent and with the important exception of certain cases of primary peritonitis there is absolute constipation. The toxæmia is marked by a high temperature and a rapid small pulse. Thirst may be intense and the tongue is usually coated and dry although in children we have not uncommonly found that the tongue may remain clean and moist even when the toxæmia is high. The most characteristic feature is the Hippocratic facies.

\* Alvarez W C. The Mechanics of the Digestive Tract, New York, 1928.



which, once seen, cannot fail to make an indelible imprint upon the memory of the clinician

Retraction of the abdomen is chiefly marked below the umbilicus, and the upper part of the abdomen may appear to be distended by contrast. The retraction, however, does not last very long, and is soon replaced by distension. The distension is not due to accumulation of fluid in the peritoneum, as a rule, but is due to distension of the intestines themselves. This distension exaggerates, if anything, the rigidity of the abdominal muscles, so that there is extreme tension inside the abdomen. Eventually the condition may lead to complete ileus.

### **Paralytic Ileus**

Paralytic ileus is characterised clinically by all the signs of high intestinal obstruction superadded to the toxæmia caused by peritonitis. The cardinal features are increased abdominal pain, marked distension of the abdomen, and increased frequency of vomiting. The vomit changes in character as the disease progresses, eventually becoming brown and fæculent. Constipation is absolute. On auscultation of the abdomen the absence of normal sounds of activity will be noted. Sharp, somewhat metallic noises may be heard in their place, due to the change of position of accumulated fluid in dilated coils of small intestine.

The toxæmia of intestinal obstruction is added to that of the peritonitis, and the twofold burden is too much for the young patient to withstand for long. The pulse rises, but the temperature falls from the original high level, and in the terminal stages is subnormal. A rising pulse rate accompanying a rapidly falling temperature is almost always a sign that a fatal issue is impending.

### The Treatment of Peritonitis

The treatment resolves itself into removing the source of the infection combating the toxæmia of the infection and preventing the development of paralytic ileus

(a) The removal of the source of the infection is naturally the first duty of the surgeon and in appendix peritonitis appendicectomy and drainage must be performed at once. In primary peritonitis however such a removal is not possible and one is at once placed at a disadvantage because of this (see Pneumococcal Peritonitis p 145)

(b) In the early stages the toxæmia is due to absorption of inflammatory toxins from the peritoneum itself and the most important line of treatment is in the administration of fluid. This should not be attempted by mouth as the taking of large quantities in this way is likely to increase the abdominal distension and to stimulate the bowel musculature which should be rested. The best way of administering fluid is by continuous rectal injection using the drip method. This however is not practicable in the case of children below the age of three or four years and as an alternative fluid should be given continuously into the subcutaneous tissues in the region of the axillæ. Normal saline containing in the case of rectal injection 10 per cent and for subcutaneous injection  $2\frac{1}{2}$  per cent glucose is used. In the latter case the fluid must be sterile

The bowels should be rested and not irritated by giving purgatives or highly irritant enemata. Bowel action may be obtained very often from the effect of the saline alone. Large warm packs applied to the whole abdomen will be found of use. Acetyl choline should be tried. To a child of say ten years it should be given intramuscularly in doses of 0.05 gm repeated at hourly intervals for six doses or until a motion is obtained. The dosage should be smaller for the younger child. A trial should be made of

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coil of jejunum gently withdrawn through it. Two light intestinal clamps are applied, one above and the other below the most prominent part of the presenting bowel, and a small incision is made into the latter on its ante-mesenteric aspect. A No. 12 soft rubber catheter is placed in the opening of the bowel and secured there by a catgut stitch. The tube is passed inside the lumen of the gut upwards and

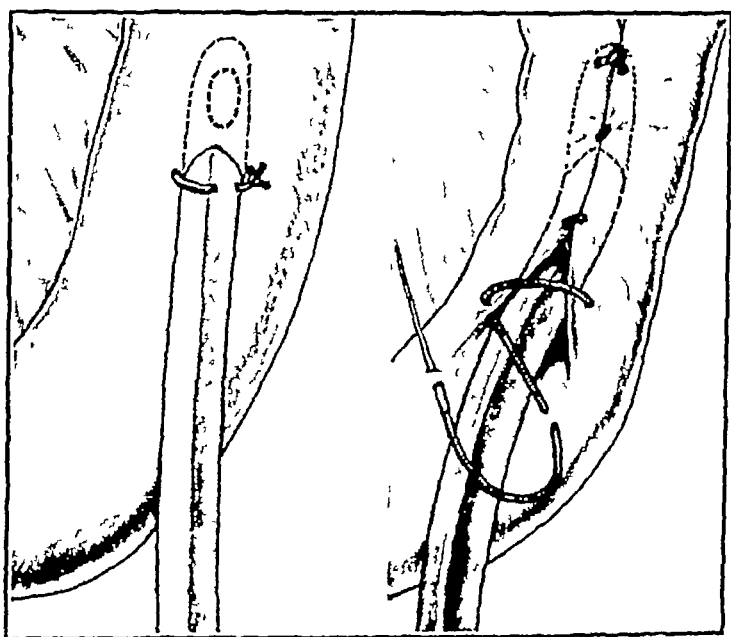


FIG. 50 — JEJUNOSTOMY.  
(For description see text)

to the left. It is buried by means of a continuous stitch of fine catgut making a channel in the wall of the bowel, as suggested by Witzel (Fig. 50). The clamps are removed and the bowel returned to the abdomen. A stitch anchors it to the peritoneum and the wound is closed with interrupted sutures. The greatest care must be taken to prevent contamination of the peritoneum by intestinal contents during the performance of the operation.

## III PNEUMOCOCCAL PERITONITIS

Pneumococcal peritonitis exists in two forms. In the first the infection of the peritoneum is part of a general pneumococcal pyæmia and accompanies or follows infection of say the mastoid process or an empyema. In the second the infection of the peritoneum is not accompanied by any detectable lesion elsewhere in the body and is thus regarded as a primary peritonitis. The source and the path of the infection in the latter type has been the subject of controversy for some considerable time and there is still doubt in regard to both these factors. The disease in this form is however far more common in girls than in boys and this suggests the possibility of the organism gaining entrance to the peritoneum via the genital tract. McCartney and Fraser\* of Edinburgh have found that all their cases of primary pneumococcal peritonitis occurred in young girls. In all the infection was greatest in the pelvis and the pneumococcus could be obtained from the genital tract. The observations made by other workers however do not tally entirely with these findings and a number of cases of pneumococcal peritonitis occur in which there is no evidence of the infection being carried by the Fallopian tubes. Further though rare primary pneumococcal peritonitis occasionally occurs in the male child. It must be conceded therefore that though the genital tract is the most common path of the infection a certain percentage of the cases are due to the infection being carried to the peritoneum via the blood stream from some obscure focus inside the body.

The disease differs in certain respects from peritonitis secondary to a focus inside the abdomen. It varies con

\* McCartney J. E. and Fraser J. *Brit Journ Surg* 1921-22 ix 479

siderably in its severity from the fulminating type of infection to one in which the clinical signs of inflammation in the abdomen are slow in making their appearance, and are of the sub-acute type. Contrary to the usual event in *Bacillus coli* peritonitis, diarrhœa is a more frequent accompaniment than constipation, and in some cases the bowels act normally throughout the disease. It has been suggested that the diarrhœa is due to the effect of a septicæmia upon the bowel wall, but this explanation is not an entirely satisfactory one. As has been stated, the disease varies from a very acute form to a very mild form. In general, the primary type is the more acute. There is severe abdominal pain, and a marked toxæmia. The physical signs in the abdomen, even in the very acute form, may be comparatively slow in making their appearance. There is no early abdominal retraction, and the abdomen remains soft to palpation. The greatest tenderness is found on rectal examination, and, as has been stated, diarrhœa is common. In the early stages a blood culture is frequently positive. In secondary pneumococcal peritonitis, in which the patient is already ill as a result of the primary focus, such as mastoiditis or empyema, the infection of the peritoneum may cause such few added features that it passes unnoticed for a considerable time, possibly until the persistent diarrhœa has drawn attention to the abdomen. It is characteristic of these cases to find that there is general tumescence of the abdomen, but there is very little rigidity and very little tenderness, and as time goes on the physical signs of a collection of fluid inside the peritoneal cavity become obvious.

### Diagnosis

The diagnosis of primary pneumococcal peritonitis can rarely be made with absolute conviction, for in the majority of cases one cannot be certain by clinical examination that

one is not dealing with peritonitis secondary to appendicitis. The chief differences to be noted between the two are however the comparative paucity of the physical signs in the abdomen in pneumococcal peritonitis the presence of diarrhoea from the outset of the disease and the absence of a history suggesting appendicitis. Peritoneal puncture has been advocated as a diagnostic measure but we have had no experience of its use. A blood culture should always be attempted.

### Treatment

The outlook in pneumococcal peritonitis except in its mildest form is not a good one and there is no unanimity of opinion as to how the condition should be treated the choice lying between immediate operation and expectant treatment. I am of the opinion that too early interference should be avoided. During the onset of primary peritonitis when there is a high temperature little is found at operation beyond a general stickiness of the peritoneum and a little free fluid. The child at this stage is suffering from a septicæmia and nothing is to be gained from opening the abdomen. The view has been put forward that operation should be postponed until the diarrhoea which characterises the onset has ceased on the grounds that this symptom is an expression of the toxæmia. Whether this conception be true or not it seems to be a wiser policy to delay operation in the hope that by medical treatment the peritoneum itself may be able to localise the infection so that an abscess is formed which the surgeon can drain with the minimum of interference. Unfortunately a great number perhaps the majority of cases do not respond in this way but a wide spread peritonitis occurs which is almost always fatal. The surgeon may possibly be reproached for not operating on one of these cases at an early stage of the disease but such a reproach is unjust for it is quite certain that the

outlook would not have been materially altered by an operation performed in the initial stages

In the second type of pneumococcal peritonitis it is obvious that operation must be delayed until localisation of the pus has occurred. The prognosis in these cases is grave by reason of the fact that the child is suffering from a pneumococcal pyæmia, of which the peritoneal focus is only a part.

**Non-Operative Treatment.**—The child should be nursed in Fowler's position and on the general lines described in the treatment of appendicitis peritonitis.

In the septicæmic stage a small blood transfusion, as suggested by McCartney and Fraser, should be given. If a positive blood culture is obtained and the pneumococcus can be typed, antipneumococcal serum should be given. We have found mercurochrome and other intravenous antiseptics to be of no value.

**Operative Treatment.**—If the condition is localised so that an abscess forms, an incision should be made over it, under gas and oxygen or local anæsthesia, and adequate drainage provided with rubber tubing. More than one abscess may be present, and separate drainage is required for each. In cases where it is clear that diffuse peritonitis is present, drainage may be employed in a similar way, but we do not advocate removal of infected Fallopian tubes at this stage, unless they lie freely in the pelvis, and are not bound down by plastic lymph.

#### IV. STREPTOCOCCAL PERITONITIS AND GONOCOCCAL PERITONITIS

Though much rarer, streptococcal peritonitis is similar in its behaviour to pneumococcal peritonitis, in that two forms can be recognised, the primary and the secondary. In a recent case the peritonitis followed erysipelas of the pubic region in a girl of three and a half years.

The prognosis in streptococcal peritonitis is most unfavourable treatment should be carried out on the same lines as for pneumococcal peritonitis. Gonococcal peritonitis is so excessively rare in children that a detailed account of the condition as exemplified by the few published cases in the literature would be out of place.



## CHAPTER XI

### ACUTE INTESTINAL OBSTRUCTION

ALTHOUGH the effects of acute intestinal obstruction in the child are similar to those in the adult, with one or two exceptions the causes are of different origin. Thus, obstruction due to a growth of the intestinal wall, so common in adults, is a great rarity in children. Acute obstruction due to intussusception of the bowel is practically limited to the early years of life, while obstruction due to congenital atresia or malrotation is naturally encountered only in infancy.

The clinical features of all cases of acute intestinal obstruction are determined in the first place by the nature of the causation, and it is only in cases of obstruction due to inflammatory bands inside the abdomen and internal hernias, comparatively rare events in children, and in volvulus neonatorum, that the condition of acute obstruction becomes a clinical entity uncoloured by an illness immediately preceding it. Whether, however, the obstruction is of immediate onset or only a terminal event of some abdominal catastrophe, the pathology of the condition remains the same. The main characteristics of the obstruction itself are abdominal pain, intractable vomiting, distension of the abdomen, and absolute constipation.

The exact nature of the prostration reached in cases of acute intestinal obstruction is not clearly understood, and opinions vary as to whether it is a true toxæmia or whether it is due to a chemical alteration in the blood plasma as a result of the loss of stomach and duodenal contents. It is wise to bear both these possibilities in mind when considering

the question of treatment. Thus apart from the obvious necessity of relieving the obstruction itself the plan of treatment should encompass the combating of both these possibilities. The main points have already been described in dealing with paralytic ileus complicating peritonitis and need not be further elaborated here.

In cases not preceded by an illness which points to the probability acute obstruction may be difficult to diagnose in the early stages. Absolute constipation is not of very great value as a symptom in itself. It should be confirmed by administering an enema to clear the lower bowel and a second enema after an interval of an hour. Should the latter be returned clear evidence of absolute obstruction is furnished. There may however be a certain amount of discharge from the intestinal wall below the obstruction and in these cases the excretion should be tested for the presence of bile. The vomiting can only be regarded as characteristic when the condition has advanced to a dangerous stage. The vomit is first of all stomach contents coloured with a little bile as the disease progresses the bile content increases in proportion and eventually the vomit is stained brown with contents of the upper reaches of the small intestine. Finally the vomit becomes definitely of the so-called *fæculant* type. The distension of the abdomen increases rapidly and is due to the accumulation of fluid and gas in the bowel above the obstruction. There is however no visible peristalsis for this physical sign is only to be observed in cases of acute obstruction superimposed upon chronic obstruction and is thus rarely seen in the child. The most important guide will be found in auscultation of the abdomen. Normal borborygmi will not be heard but in its place a somewhat metallic sound due to displacement of intestinal contents within the distended loops of bowel. The effects of dehydration coupled with the possible toxæmia and the loss of chlorides from

the blood plasma, will be obvious very early in acute obstruction in childhood, and the younger the child the more swiftly is the climax approached. Thus the need for early recognition of the nature of the condition is of supreme importance. In the following pages only acute obstruction due to acquired causes is described, those depending upon congenital malformations of the bowel will be found in Chapter XII.

### I. STRANGULATED AND IRREDUCIBLE HERNIA

Strangulation in children is limited to inguinal hernias, umbilical and femoral hernias being practically immune to this complication. The condition is a rare one. It frequently happens that an inguinal hernia becomes irreducible, but in the vast majority of cases the hernia goes back under treatment. The first sign is perceived by the mother, who notices that the hernia, which probably had previously been recognised, suddenly becomes larger and harder.

There are, as a rule, in this early stage no symptoms which suggest that the intestine is involved. The cause of the inability of the hernia to go back is probably a sudden increase in its contents, and the barrier to its return may be either at the internal ring or, what I believe to be the more usual, at the external ring. It is possible that the cause of the obstruction to the return of the hernia is due to a delayed attempt to obliterate the funicular process. Attempts to reduce the hernia must be made without delay. Taxis should be employed, but sparingly, and it is a mistake to make a long continued manipulation. The great majority of cases will go back spontaneously if the child is nursed with the head lowered. In the case of small children the feet should be tied to a Balkan beam placed across the bed, so that the buttocks are clear of the mattress, and the reduction aided by either hot fomentations or cold com-

presses. A homely method is illustrated in Fig 51. The action of the cold is particularly important for it stimulates the tunica dartos. One writer suggests that a blast of cold air blowing on the child may have the desired effect and in this connection the famous case of strangulated hernia described by Petit in the eighteenth century will be

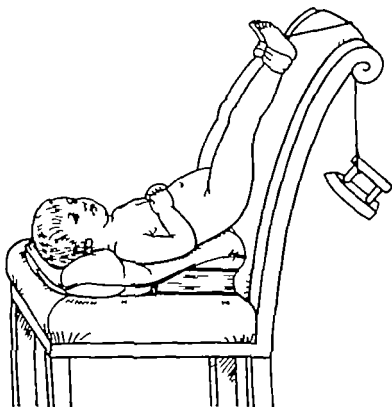


FIG 51 —A SIMPLE METHOD OF REDUCTION OF AN IMPACTED HERNIA IN AN INFANT

recalled in which an operation was prevented by the timely intervention of the child's grandmother who threw a bucket of cold water over the patient. The violent stimulation of the tunica dartos produced a spontaneous reduction of the hernia.

Should at any time symptoms suggestive of obstruction of the bowel supervene (a comparatively rare event in the

ordinary type of irreducible hernia), operation must be considered. If an inguinal hernia is going to strangulate, symptoms and signs are, as a rule, acute from the first. The hernia is usually a small one. It suddenly becomes larger and tense and the child suffers a considerable degree of pain, and with this there is vomiting. On examination the hernia will be found tense and tender, and there may be œdema of the overlying skin. With the symptoms and signs so well defined as this, immediate operation is probably the wisest course, for it is extremely dangerous to make any attempt at taxis, as this is almost inevitably doomed to failure on account of the swelling of the contents of the sac. The signs of strangulation in a very young infant may be ill defined, and strangulation of a portion of the bowel may occur in what appears to be merely an obstructed hernia. The following case illustrates this point.

J. W., aged twenty-three days, was first seen two days after his nurse had noticed a large tense swelling in the right inguinal region. The child had been sick two or three times, and the bowels had not moved for twenty-four hours. On examination of the hernia it was noted to have an impulse when the child cried, and was therefore adjudged not to have strangulated. The feet of the child were tied to a Balkan beam, and after a few hours the swelling had become considerably smaller. The child had not vomited again, took his usual feed from the breast, and the bowels were opened. In the evening of the following day, although the patient was still held suspended by the legs, the hernia again became prominent, and the child vomited two or three times. Operation was no longer delayed, and, under a local anæsthetic, a large sac was opened, containing a loop of non-obstructed ileum. At the apex of the loop, however, the gut was swollen and grey, and there was a grooved furrow surrounding it. No perforation was present, and the intestine was returned to the abdomen after relieving the obstruction at the external ring. The child made an uninterrupted recovery.

There may be some difficulty in diagnosing a strangulated inguinal hernia from torsion of the testis for both are associated with pain sickness and a tender scrotal swelling. No great harm is done should the differential diagnosis not be correctly made for in both conditions operation is indicated.

### Treatment

The treatment of strangulated hernia is operative and no time should be lost once the surgeon is satisfied that strangulation has occurred. The incision is made directly over the swelling under gas and oxygen or local anæsthesia the latter being particularly suited for the very young infant. The sac is easily defined on account of its distension. It must be steadied with forceps and opened with a knife at its fundus for in strangulation there is always a cushion of fluid between the fundus and the contents of the sac and by opening the latter in this situation the surgeon will avoid damage of the contents (Fig 52). The hernial orifice should now be examined. As a rule the constriction will be at the external ring and this should be divided along a grooved director. In the case of the very young child it will be sufficient to dilate the constricted ring by means of a sinus forceps. As soon as the constriction has been relieved a little more of the bowel above the obstruction should be brought into view. It is at this stage that there may be some difficulty in deciding what procedure to follow. The bowel especially near the apex of the obstructed loop will be swollen and frequently it will be dull greyish in colour. When gangrene



FIG 52 —STRANGULATION OF AN INGUINAL HERNIA.

There is a cushion of fluid separating the fundus of the sac from the hernial contents. The sac should be opened at the point indicated by the arrow.

is present, the gut will be black, but this happily is a rare event in strangulated hernia in children. The thing to remember is the extraordinary powers of recovery that the intestine has in the child. If the gut is black, there will of course be no recovery, when the intestine is a deep grey, it will probably recover after the obstruction has been released, in spite of the fact that signs of recovery are not immediately apparent. At all events, the surgeon will be wise if he gives the intestine the benefit of the doubt and returns it to the abdomen, in cases about which he is of two minds, for the only alternative in the young infant is resection, an operation attended by an extremely high mortality. If the gut is gangrenous, then resection should be undertaken, for the method of bringing the gangrenous area outside the abdomen and of performing an enterostomy above it is always fatal. The affected bowel, which is always of short length, may be removed between large Spencer Wells after the mesentery has been secured. The ends of the bowel are ligatured, and the stumps buried by purse-string sutures. A small lateral anastomosis is then performed and the intestine returned to the abdomen (Fig 63).

## II. INTUSSUSCEPTION

Intussusception is the invagination of a portion of the bowel into the segment continuous with it. Its acute form is practically confined to young children, and is almost always of the primary or idiopathic type. That is to say, there is no local lesion of the bowel, such as a pedunculated growth, which acts as the exciting cause. The one exception to this generalisation is in the case of Meckel's diverticula, which occasionally are responsible for the origin of an intussusception (Chapter XII).

The cæcal region of the bowel and the last few feet of the

ileum are easily the most frequent portions of the bowel to be affected. The bowel is invaginated into its adjacent segment and once this has happened a species of swallowing occurs which progresses until the tension inside the swallowing portion becomes so great that the engulfing action is arrested.

The intussusception is composed of three layers of bowel wall—the entering layer, the returning layer, and the ensheathing layer. The part of the bowel which first enters is known as the *apex* and the *neck* of the intussusception is

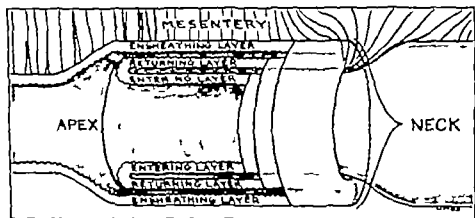


FIG 53—INTUSSUSCEPTION SECTIONAL DIAGRAM

the circular zone at which the entering layer has passed into the ensheathing layer (Fig 53).

It must follow that as the entering layer is swallowed it takes with it its mesentery in which is carried its blood supply. It is because of this that pathological changes occur in the invaginated portion. As a result of pressure of the ensheathing layer upon the mesentery at the neck, the venous return is impeded and the intussuscepted portion becomes engorged with blood. The engorgement is chiefly marked at the apex of the intussuscepted portion as this is the furthest point from the site of obstruction. At a comparatively early stage the submucosa in this situation



is so congested that mucus is secreted in excess and eventually is admixed with blood from rupture of the engorged vessels in the intestinal villi (Fig 54) Hence the bowel distal to the intussusception becomes filled with

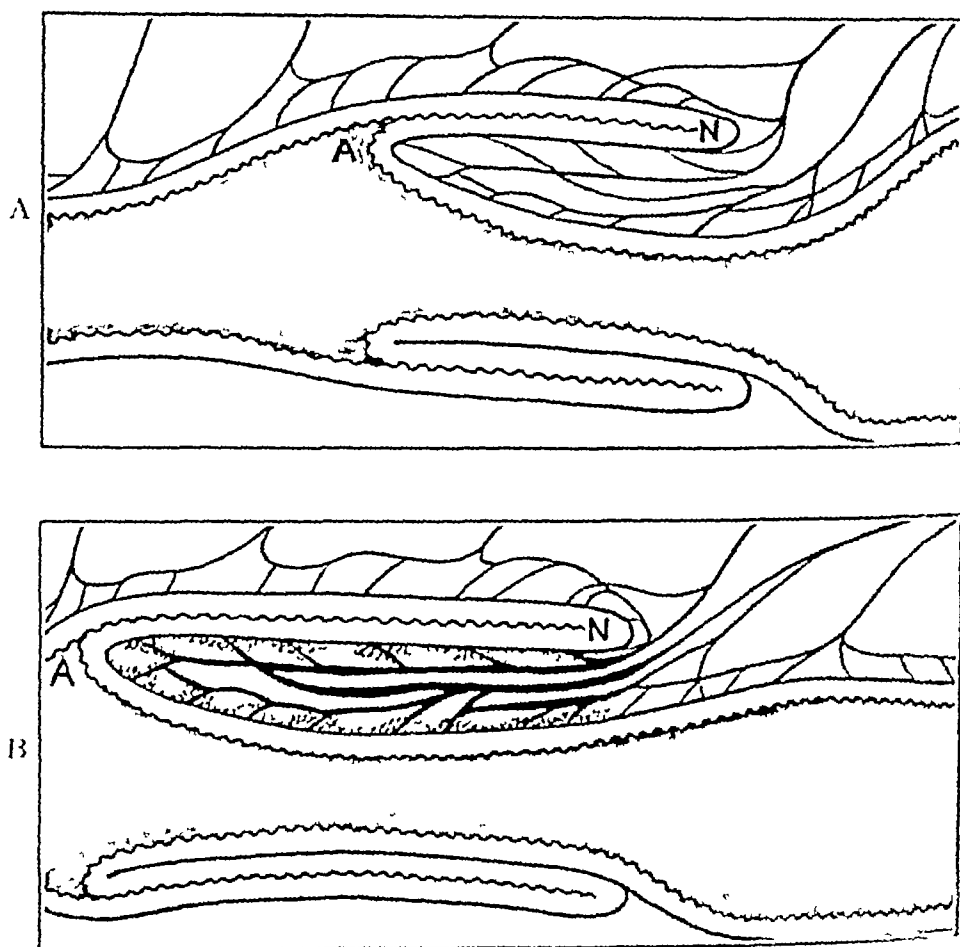


FIG. 54

A The mesentery is taken into the intussusception by the enteric layer. B As the intussusception increases in size the tension at the neck (N) increases so that the mesenteric veins become congested.

bloodstained mucus which the infant passes per rectum and this is one of the cardinal signs of the condition. Ultimately the pressure at the neck may come to exceed that of the blood in the mesenteric arteries so that the blood

supply to the intussuscepted portion becomes cut off *in toto*. The result is moist gangrene the changes of which commence first in the apex and spread backwards to the neck. Eventually perforation of the bowel at the neck may occur with subsequent infection of the peritoneal cavity. Cases have been reported in which the three layers have become glued together at the neck by peritoneal reaction and the intussuscepted portion consisting of the entering and returning layers has sloughed away and has been subsequently passed per rectum with recovery of the patient. Such a happy outcome is however an exceedingly rare event.

The extent to which the intussusception progresses before it is arrested depends in the main upon the anatomy of the affected portion. Thus if the intussusception occurs in the ileum (ileo-ileal) it does not usually exceed five to six inches in length before the tension inside becomes too great for further progress. On the other hand should the apex of the intussusception be the ileo-cæcal valve—as is frequently the case—the great difference in calibre between the entering bowel (the ileum) and the ensheathing bowel (the cæcum and ascending colon) permits the intussusception to advance quickly and to grow to a considerable length. If the cæcum and ascending colon are mobile—again a frequent association—the progress of the intussusception may be so free and so rapid that its apex may reach the anus within a few hours of the onset. It will readily be appreciated how much more serious an ileo-ileal intussusception is than an ileo-cæcal by these tokens alone. Other factors to be mentioned later are also present which make the differences between the two greater still in this respect.

The actual mechanism of these two types—the ileo-ileal and the ileo-cæcal—is readily understood. In both cases the part of the bowel first entering remains the foremost part of the intussusception & the apex throughout and

the intussusception increases in length at the expense of the ensheathing layer (Fig 55) Thus in the ilco-cæcal cases, for example, the cæcum and ascending colon become taken up as the intussusception increases (Fig 56)

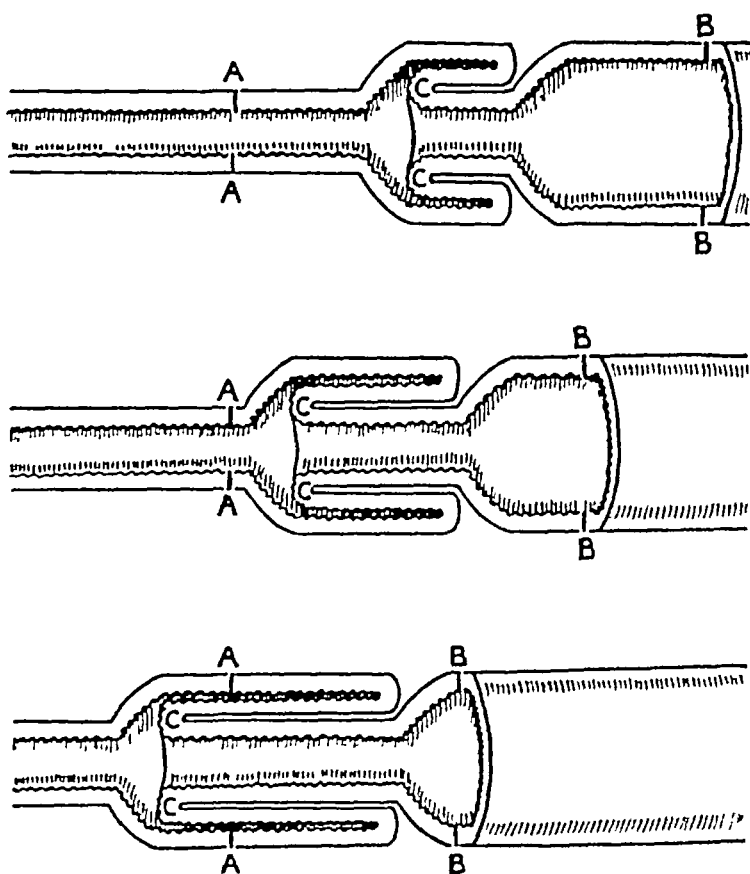


FIG 55 —INTUSSUSCEPTION SECTIONAL DIAGRAM OF PROGRESS IN ILEO-ILEAL AND ILEO-CÆCAL TYPES

The intussusception increases at the expense of the ensheathing layer, which becomes taken up, the apex (C) remaining constant. The distance between C and B, representing any point on the entering layer, also remains constant—the distance diminishes between C and A, representing a point on the ensheathing layer.

The type of intussusception which is probably the most common is, however, the least understood. This is the ileo-colic, in which both the ileum and the colon participate. This type can usually be recognised at operation by the fact

that the intussusception involves the ileo-cæcal region but neither the cæcum nor the ascending colon is taken up so that the vermiform appendix remains outside and is thus readily visible to the surgeon

It is probable that there is more than one variety of ileo-colic intussusception. The commonest form appears to be that in which the point of origin is in the last few inches of the ileum the intussuscepted portion passing

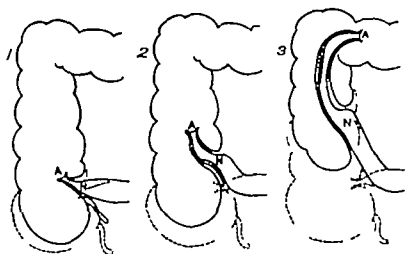


FIG 56—ILEO-CÆCAL INTUSSUSCEPTION THE APEX (A) BEING THE ILEO-CÆCAL VALVE

This remains unchanged so that as the intussusception progresses the cæcum and appendix are taken up

through the ileo-cæcal valve into the ascending colon. In this case the intussusception does not increase at the expense of the ensheathing layer however and thus differs from the ileo-cæcal and pure ileo-ileal types. The apex constantly changes and the increase in size is due to fresh bowel entering. This is best appreciated by reference to the diagrams (Fig 57)

In some cases of this type when progress in the way described has been arrested the intussusception itself invaginates *en masse* into the colon whereupon further

increase occurs at the expense of the new ensheathing layer, and the cæcum and beginning of the ascending colon are taken up. The intussusception is now a double one, and clearly will not be able to progress very far before it is

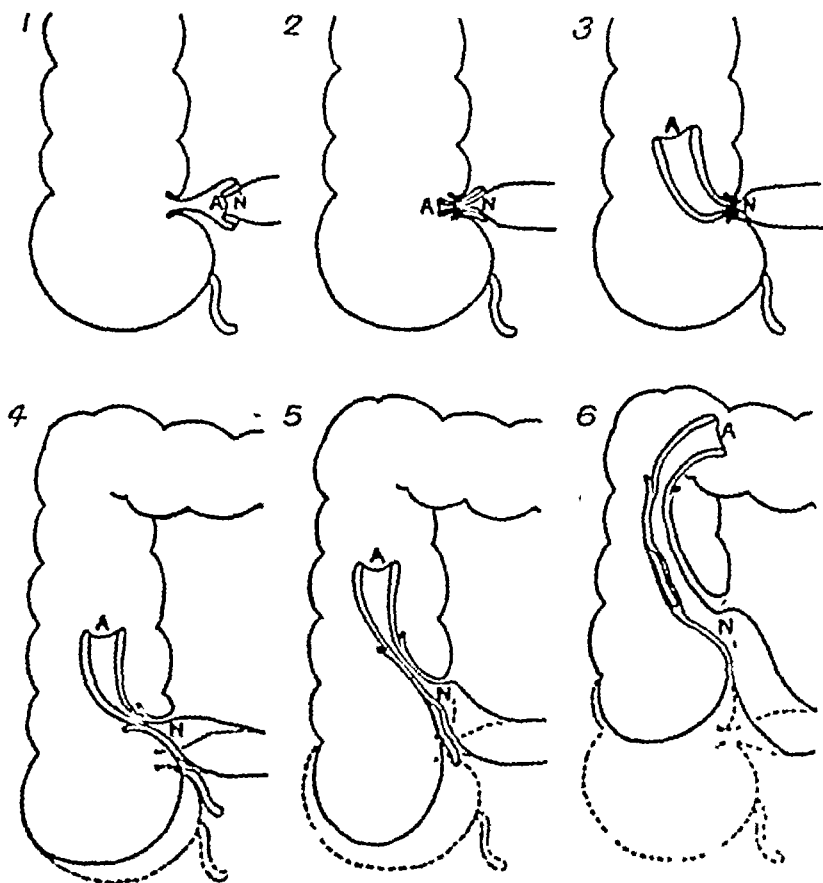


FIG. 57.—ILEO-COLIC INTUSSUSCEPTION

The apex is constantly changing, so that the intussusception increases at the expense of the entering layer. The intussusception starts in the terminal portion of the ileum and passes through the ileo-cæcal valve. The cæcum and appendix are not taken up at first (1, 2, and 3), but may be subsequently (4, 5, and 6).

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ileo-ileo-cæcal have  
intussusception.

out little purpose is served thereby and the more simple term ileo-colic is thus retained for them.

Pure colo-colic intussusception is rare and does not save in exceptional cases give rise to acute symptoms necessitating urgent surgical intervention. For other rare forms see p. 183.

We may thus classify the common forms of acute intussusception into three groups: ileo-ileal, ileo-cæcal and ileo-colic. Of these ileo-ileal is quite easily the least common—a fortunate fact indeed for it is the most dangerous form. Fully 80 per cent. of all acute intussusceptions are either ileo-cæcal or ileo-colic. Which of these two is the more frequent has been for some years a matter of controversy and we are content to leave it so for it is unimportant. Formerly considered a rarity, the ileo-colic type is regarded to be at least as common as the ileo-cæcal.

#### MECHANISM AND CAUSATION

In the primary acute intussusception there is no polyp or other new growth of the intestine which acts as a predisposing cause to one part of the bowel being swallowed by its neighbouring segment. The condition is primary or idiopathic in the strictest sense of the word. We are still in ignorance of the exact causation. At operation one always finds that the Peyer's patches in the terminal portion of the ileum are enlarged and the lymphatic glands draining them are also increased in size and it has been suggested that a Peyer's patch itself may act like a polyp to become the forerunner of an intussusception. Perrin and Lindsay\* hold this view. Excessive mobility of the cæcum is also held to be a cause but this must be regarded as an attendant circumstance rather than a factor in the etiology. It seems

\* Perrin W. S. and Lindsay E. C. *Brit Journ Surg* 1921 ix. 46

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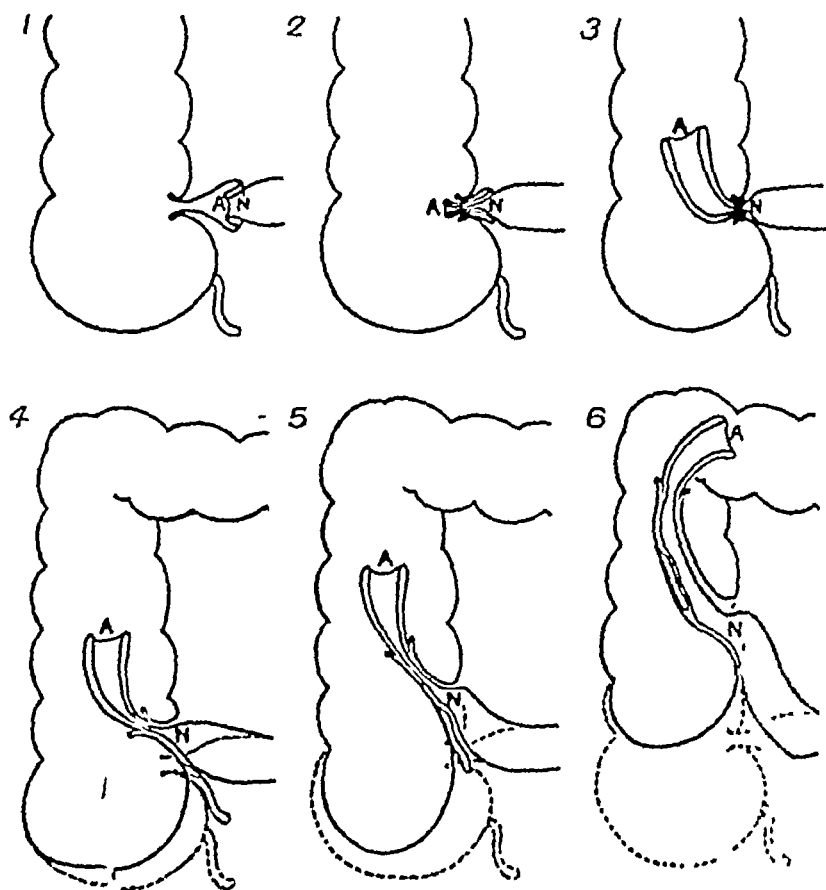


FIG. 57.—ILEO-COLIC INTUSSUSCEPTION.

The apex is constantly changing, so that the intussusception moves at the expense of the entering layer. The intussusception starts in the terminal portion of the ileum and passes through the ileo-caecal valve. The cæcum and appendix are not taken up at first (1, 2, and 3), but may be subsequently (4, 5, and 6).

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probable that an intussusception owes its initiation to an inco-ordination of muscular action. By this is meant an aberration of the normal action of peristalsis. Normally the peristaltic wave is preceded by a wave of relaxation. If for some reason an area of the bowel is firmly and persistently constricted about a given area, any wave of relaxation which meets it must stop abruptly, as such a wave cannot pass through a constricted area. Should such a constriction ring, as it might be called, persist, the effect of wave on wave of peristaltic action may be to enforce this constricted area into the segment of bowel adjacent to it, and thus initiate an intussusception. Alvarez\* has, by very careful experimental work, established that the stimulus for contraction of plain muscular tissue is myogenic and that the excitability of intestinal musculature varies considerably according to its physical state. The muscle which is adjacent to an inflammatory lesion will be in a high state of excitability, and persistent spasm of a localised area may occur. Such a view of the causation of intussusception is well reconciled with the known pathological facts. The Peyer's patches and the lymphatic tissue in general at the lower end of the ileum are swollen, due unquestionably to enteritis. It is not uncommon, indeed in cases of intussusception to find that there has been some dietetic upset preceding the acute attack. Such a localised inflammatory state of the intestine will induce hyper-excitability of the musculature and lead to inco-ordination of muscular action.

The child is usually a healthy lusty male, one whose bowel musculature is capable of strong contractions. The maximum incidence lies between the fifth and ninth month, a fateful period during the life of the infant, for it is at this

liquid to a partially solid one. At this period of life especially in hospital classes indiscretions in the child's diet more particularly in the healthy type of child who is the usual subject of intussusception are likely to occur. Barrington-Ward\* asserts that the number of cases in hospital practice is generally increased after a popular festival such as Christmas or Easter. The brunt of all intestinal upsets is borne by the terminal part of the ileum and thus any changes in the gut as a result of these dietetic indiscretions will be most marked around the ileo-cæcal region the site of origin of intussusception.

### Clinical Signs

In the majority of cases the diagnosis is not a matter of difficulty—a fortunate fact for the success of treatment lies entirely in an early diagnosis. The cardinal signs are three in number pain the passage of blood per rectum and a swelling in the abdomen. It should be possible to diagnose the condition before the stage at which blood is passed especially in the ileo-ileal type and in the ileo-colic type for in them blood may not be passed for some considerable time after the onset of the intussusception.

The clinical progress may be divided into phases. The first of these is the phase of onset before blood has been passed and the two features of this phase are abdominal pain and sickness. The pain is a paroxysmal one and as a result of it the infant screams and draws its knees up on to the abdomen. This screaming attack may come without any warning the child previously being happy and in good health though more frequently there is a history of irritability or a mild attack of enteritis. The cry has an abnormal quality which the mother is quick to recognise. The period of crying may last for a minute or two perhaps

\* Barrington Ward L. E. *The Abdominal Surgery of Children*  
Oxford Medical Publications 1928

a little longer. The child becomes very pale, but he soon recovers and a period of calm follows during which the child is apparently happy again. After the lapse of a variable interval, perhaps an hour or two, this event is repeated, and the mother may now be in a genuine state of alarm, and seeks medical advice.

Sickness is not a very marked feature. As a rule, the child vomits once or twice during the early attacks of pain, and the vomit consists of stomach contents. It is said to be characteristic that in the intervals between the acute attacks the child will refuse all food offered, and L'èvre\* regards this, coupled with the attacks of pain, as a sign of considerable importance in the early diagnosis of the condition. Thus the first phase is marked by intermittent screaming attacks with occasional vomiting.

The second phase may be described as that in which blood has been passed per rectum. The blood, as a rule, is bright in colour and intimately mixed with mucus. The time incidence of its appearance varies considerably according to the type of intussusception present. In the ileo-cæcal variety it may be an early sign. The mother may notice it after the first two or three attacks of screaming, and it will be this which so thoroughly alarms her. In the ileo-ileal type of intussusception, however, blood may not be noticeable for two or three days after the onset, by which time the intussusception is likely to be gangrenous. It is urged, therefore, that the passage of blood per rectum is not necessarily an early sign, and its absence should not put the surgeon off the diagnosis. The blood will be noticed on the napkin, or upon the examining finger when rectal examination is made. The blood and mucus may resemble the motion in gastro-enteritis. Although obstruction eventually is complete, it is not so in the early stages of the disease. In any case the large bowel may be emptied after the

\* L'èvre, M., "Chirurgie d'Urgence" Paris, 1933

onset and there may be a certain amount of small intestine contents apart from blood and mucus passed by the second motion. Thus care must be exercised in deciding against the diagnosis of intussusception because the usual two-enema method of diagnosis of acute obstruction is not positive. At the stage when blood is passed a lump is to

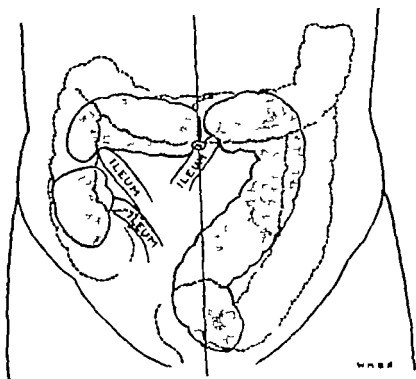


FIG 58 — PROGRESS OF INTUSSUSCEPTION

The bowel is dragged upon as the result of the mesentery entering into the intussusception so that as the tumour increases in size it gets progressively closer to the mid-line of the body

be felt in the abdomen. This is commonly described as a sausage-shaped swelling. It is to be examined for mainly in two situations. On the right side underneath the liver and in the line of the transverse colon and on the left side just lateral to the mid abdominal line. This is the track of the ileo-caecal and ileo-colic intussusception although the latter will rarely progress beyond the mid line (Fig 58)

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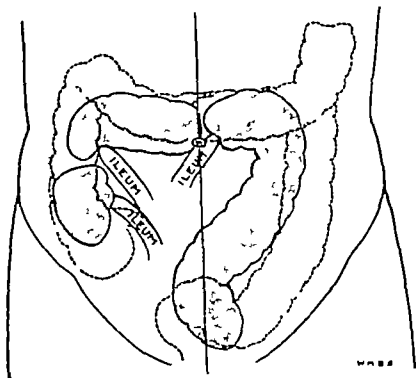


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The intussuscepted mass will never be found in the right iliac fossa. The cæcum in infants is always high, and in the ileo-cæcal variety itself the cæcum is, of course, taken up. It is this absence of the cæcum from the right iliac fossa which has led to the well-known "signe de Dance," or the feeling of emptiness in the right iliac fossa—a sign of little value to the clinician. In small intestine cases the mass is to be felt low down in the hypogastrium and situated deeply upon the posterior abdominal wall. Its detection may be a matter of considerable difficulty, and it can easily be overlooked. Similarly, in the fat and lusty child who is usually the subject of intussusception, the lump tucked up under the liver in ileo-cæcal intussusception may be very difficult to feel. No attempt should be made to examine the child during an attack of pain, for nothing of value will come from so doing, but the surgeon must wait until the child is in a period of calm. If the condition has gone on for some hours, then the child will probably fall asleep in the intervals between the pain, and examination is thus made easy. The clothing should be disturbed as little as possible, and the abdomen very gently felt with a warm hand. If the right hand is laid across the abdomen gently and palpation carried out slowly, with firmness but without any sudden pressure, it will be possible in the majority of cases to feel the lump. In doubtful cases it may be regarded as advisable for an anæsthetic to be given so that the abdomen may be palpated more easily, but we personally do not recommend this step, for it has obvious disadvantages. If doubt is present to this extent, it would be preferable to aid the diagnosis by X-ray examination with a barium enema should facilities be available.

A point which has been emphasised by many observers is that in acute intussusception the lump may be felt to harden under the examining hand. I have never had an opportunity of confirming this, for I have always found that

the first evidence of any hardening process is shown by the onset of a screaming attack and the abdominal wall is suddenly contracted and one can no longer feel the lump. Rectal examination need be carried out only in cases in which the diagnosis is not clear for examination is disturbing to the child. The index finger of the right hand should be used. In ileo-cæcal cases in which the intussusception has advanced rapidly the apex may be felt in the rectum. Bimanual palpation may be employed with one finger in the rectum and a hand on the abdomen. Unfortunately the child will always be crying during this examination so that the abdominal wall is contracted strongly but with the added resistance that the hand on the abdominal wall offers to the rectal finger it may be possible to feel in this way an ileo-ileal intussusception lying in the hypogastrium. On withdrawal the finger stall will be examined for blood.

The decubitus is characteristic and between the attacks the child is apathetic and listless. There is marked pallor and this can be noted even on the face of the sun burned fresh air baby. The eyes are somewhat sunken and may be held half-open and the whites of the eyes appear to look unusually white. The temperature is variable and of little significance. In the later stages it is subnormal but during the first hours of the onset of the disease it may be raised.

The third phase may be regarded as the terminal phase or phase of complications. In this the child will be in an entirely apathetic state and there will be no more screaming attacks for the intussusception has become completely arrested and the bowel in the neighbourhood paralysed. It is a stage of absolute obstruction. The abdomen becomes distended and vomiting commences. At this stage operation is of little avail for not only is the child gravely ill as a result of the toxæmia of intestinal obstruction but the intussusception will almost certainly prove to be irreducible.

Cases of acute intussusception have been known to



recover spontaneously, and in my own experience this happened in one instance. During examination in the outpatient department a mass could be felt in a child with a characteristic history of acute intussusception. At operation, which was performed within two hours, no intussusception was present, but there was an area of extreme congestion of the ileum immediately adjacent to the ileo-cæcal valve which was clearly the result of an acute intussusception which had undergone spontaneous reduction. Cases in which the intussuscepted mass has sloughed away completely from the bowel and has been passed whole per rectum, with consequent recovery of the child, have already been referred to, but this must be an event so rare that no reliance should ever be placed upon its happening in any particular case.

### **Diagnosis**

The diagnosis in a typical case is comparatively easy. It is most likely to be at fault in cases of ileo-ileal intussusception because of the difficulty in this type of feeling the lump and because of the absence in it of a history of the passage of blood per rectum. One must be careful in the performance of a rectal examination in these small infants not to injure the delicate mucous membrane of the anus, for this may easily be done unless one is gentle, and will result in the presence of blood on the examining finger. Errors in diagnosis are relatively few, and it is our experience that at the present day the cases are diagnosed by the general practitioner at a much earlier date than must have been the case in former years, and it is comparatively rare except in ileo-ileal intussusception to find that the diagnosis has not been made until the condition is advanced to the stage in which surgery is of little value. One of the possible mistakes is to regard the condition as acute enteritis or entero-colitis. In these

conditions there will however be no mass and the abdominal pain evidenced by the attacks of screaming is not likely to show the paroxysmal nature characteristic of intussusception. Anal prolapse and prolapsed rectal polyp may conceivably be mistaken for intussusception. At all events these two conditions figure prominently in the differential diagnosis in textbooks of surgery. The most superficial examination of the anal margin will enable a distinction to be made between them and acute intussusception. A very real error into which one may fall in the diagnosis is in connection with Henoch's purpura especially in older children. In Henoch's purpura there may be attacks of abdominal pain, passage of blood per rectum and to complete the triad of cardinal features a lump in the abdomen. The lump is due to bleeding into the wall of the bowel and is usually to be felt in the region of the sigmoid colon. Bleeding from other sources such as the mucous membrane of the mouth will usually be present and will enable Henoch's purpura to be distinguished from acute intussusception. The distinction however may be a very difficult one to make and it is on record that both Henoch's purpura and intussusception have occurred simultaneously. In such circumstances the diagnostician is palpably defeated. Acute appendicitis, ulceration of Meckel's diverticulum and early peritonitis are all mentioned as possible diseases entering into the differential diagnosis. In acute appendicitis the initial symptoms of acute pain in a young child may certainly give rise to thoughts of acute intussusception but the other cardinal features of the latter are not present. The misdiagnosis is however not a serious one from the standpoint of the patient for in both conditions the treatment is operative.

**Radiography**—When the diagnosis is in doubt X ray examination with a barium enema may be of some value. X rays will show the presence of ileo-caecal intussusception

recover spontaneously, and in my own experience this happened in one instance. During examination in the out-patient department a mass could be felt in a child with a characteristic history of acute intussusception. At operation, which was performed within two hours, no intussusception was present, but there was an area of extreme congestion of the ileum immediately adjacent to the ileo-cæcal valve which was clearly the result of an acute intussusception which had undergone spontaneous reduction. Cases in which the intussuscepted mass has sloughed away completely from the bowel and has been passed whole per rectum, with consequent recovery of the child, have already been referred to, but this must be an event so rare that no reliance should ever be placed upon its happening in any particular case.

### Diagnosis

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described as the third phase of intussusception and in whom operation is not likely to be of much avail pre-operative treatment of this nature may be undertaken for in those cases in which there has been two or three days delay a further delay of a few hours will be repaid if the general condition of the patient can be improved

The anæsthetic of choice is gas and oxygen with a minimum of ether. The incision which will be found most useful is that which passes to the right of the mid line being some  $3\frac{1}{2}$  inches long and half above and half below the umbilicus. The rectus muscle may be dissected from its sheath and retracted or split near its medial margin and the peritoneum divided. When the peritoneum is opened the operator must guard against the sudden protrusion of coils of small intestine from the abdomen because this is an accident which adds very considerably to the shock of the operation. When breathing is quiet again four fingers of the right hand are gently slipped into the abdomen through the incision towards the situation at which the lump has been felt prior to operation. In the ileo-colic type and in the ileo-cæcal when the intussusception has not travelled far this will be comparatively easy but I have experienced difficulty in reaching the intussusception with the hand when the latter has travelled as far as the splenic flexure. It must be remembered that owing to the traction on its mesentery the intussuscepted mass lies deeply on the posterior abdominal wall. If one cannot feel the mass in this situation plainly by this blind method the hand should be withdrawn and the omentum defined and used as a guide when inserting the hand a second time. It will now be a comparatively simple matter to reduce the intussusception. If the hand inside the abdomen be placed deep to the intussusception reduction can be achieved by gently pressing the distal end of the intussusception against the anterior abdominal wall the left hand being used outside

the abdomen for counter pressure (Fig 59) It may be possible to reduce it with two fingers, embracing the bowel between them. In early cases intussusception can be reduced in this way with comparative ease In fact, it may actually race the reducing fingers in reducing itself, and it will be necessary for the hand inside the abdomen to follow it up towards the right iliac fossa The last part of the intussusception will be the most difficult to reduce,

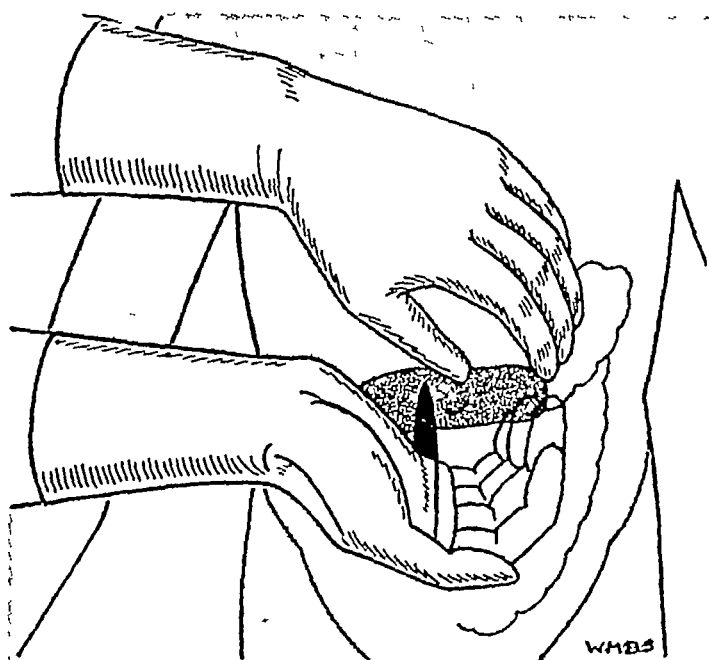


FIG 59—REDUCTION OF INTUSSUSCEPTION

Four fingers of the right hand pass into the abdomen, and the left hand makes counter pressure on the abdominal wall

although in some cases it almost reduces itself by this blind method In all cases, however, whether it is felt that complete reduction has been achieved or not, the caecum must now be lifted out from the wound to make certain upon this point This will be quite an easy manœuvre, for in all these cases the caecum is very mobile Care must be exercised when the hand inside the abdomen is withdrawn that no coils of small intestine escape from the wound with

it With the cæcum thus withdrawn it will be obvious whether reduction has been complete or not (Fig 60) In those cases where it is incomplete (Fig 61) there may be some difficulty in reducing the last inch or two of the ileum This should be attempted first of all by pressure with hot moist swabs upon the cæcum which can be compressed by both hands Should this fail very gentle traction should

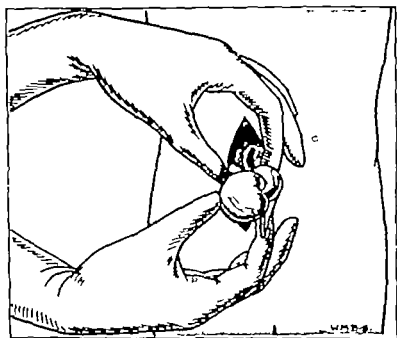


FIG 60—REDUCTION OF INTUSSUSCEPTION

The cæcum and terminal portion of the ileum are withdrawn from the wound for inspection to ensure that the intussusception has been completely reduced

be made upon the ileum. It occasionally happens that reduction is prevented by a tight fold of peritoneum crossing the cæcum and the anterior cæcal artery itself may act as a bar to reduction In such cases the artery and the fold in which it lies should be divided between forceps and in the great majority of cases complete reduction will be achieved If further difficulty is experienced in reducing



the last portion, the constricting ring of bowel may be divided at its border with a pair of narrow-bladed scissors. Reduction is then readily accomplished, and the resulting wound in the cæcum must be repaired. If, during reduction, the peritoneal coat is torn, it is better not to attempt to suture it, for little harm will result. At the end of the

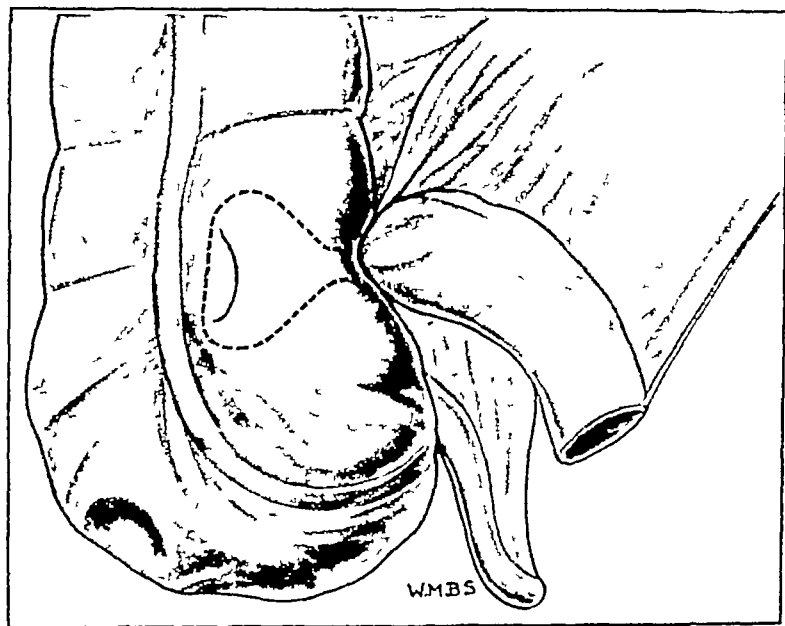


FIG 61—TYPICAL APPEARANCE FOUND WHEN THE ILEUM AND CÆCUM ARE WITHDRAWN FOR INSPECTION

The last portion of the intussusception has not yet been reduced. Note the dimple on the outer wall of the cæcum. This is a common finding, but there is some doubt as to its cause.

operation the ileo-cæcum must be carefully replaced in the right iliac fossa and the abdomen can then be closed.

*Closure of the Abdomen*—It is sometimes quite difficult to close the peritoneal layer at the end of the operation, owing to the wanton way in which coils of small intestine endeavour to escape from the abdomen. The great omentum itself may also be a hindrance. In such cases it will be found easier if a moist pack be put into the upper end of the wound and the peritonæum sutured at

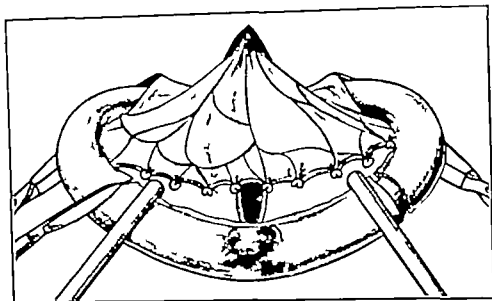


of the opinion that the operation of ileostomy, leaving the intussusception untouched, is to be condemned, for the young baby will have no possible chance of survival. One of two things should be done:

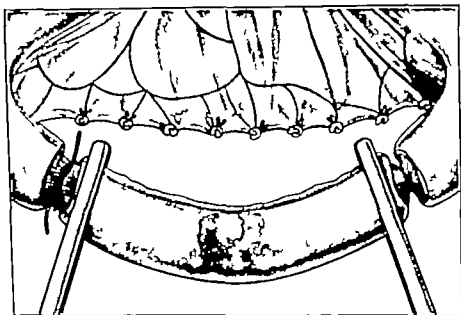
- (a) Resection of the intussusception and intestinal anastomosis
- (b) The operation suggested by Jessett and Barker

(a) In ileo-ileal cases this is the method of choice. The ileum above and below the intussusception is clamped between large Spencer Wells forceps and divided. The mesentery passing to the intussusception is quickly tied and the intussusception removed. The divided ends of the bowel are tied off and the Spencer Wells removed, and the ligated ends are then invaginated into the bowel by means of a purse-string suture. Held in small non-crushing intestinal clamps, the two portions of the ileum are laid alongside one another overlapping for a distance of 3 inches. A continuous sero-serous stitch of fine catgut is first inserted and the bowel on either side opened over a distance of about 2 inches. The cut edges are now united by a continuous over-and-over stitch, and when this is complete the line of sutures is covered over by a further sero-serous stitch (Fig 63). The operation is not difficult, but one must work quickly. The chief difficulty may be met in dividing the mesentery to the intussusception, as the former may be very much shortened as a result of the drag upon it by the entering layer. As after the intussusception has been resected the ends of the bowel are overlapping, the mesentery too will overlap to form a double thickness, and there is no call for any repair of the wound in it.

(b) The Jessett-Barker operation is more suited to cases in which the large bowel is involved. A linear incision is made through the outer layer of the intussusception and the bowel opened so as to expose the intussuscepted mass.



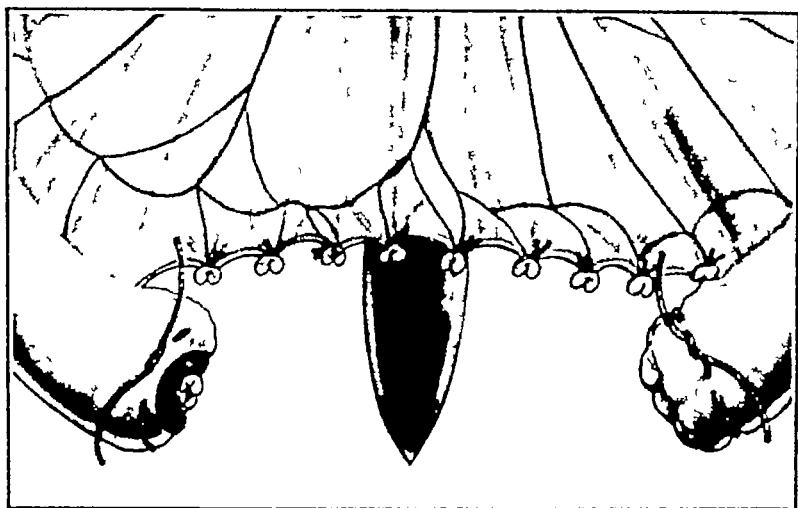
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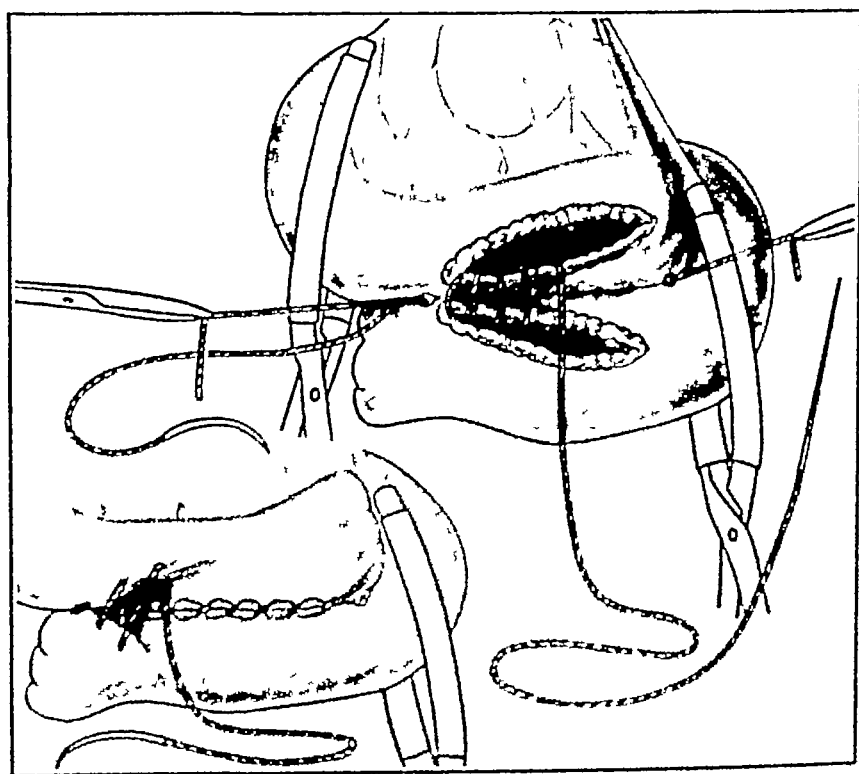
B

FIG 63—STEPS OF OPERATION FOR RESECTION AND INTESTINAL ANASTOMOSIS

(For description see text )



C



D

FIG 63 —STEPS OF OPERATION FOR RESECTION AND INTESTINAL ANASTOMOSIS  
(For description see text)

This is amputated close to the neck of the intussusception and a few interrupted sutures are placed at the junction of the entering bowel and the neck of the intussusception on the outside. The wound in the outer covering is then closed with a continuous stitch (Fig 64). I have no actual experience of this method of operation but it appears to

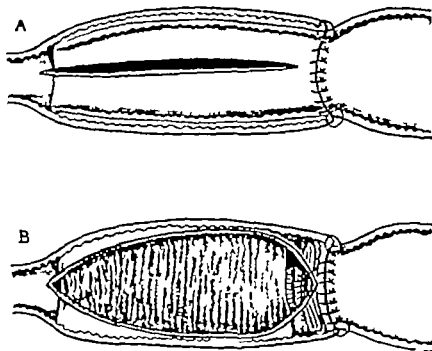
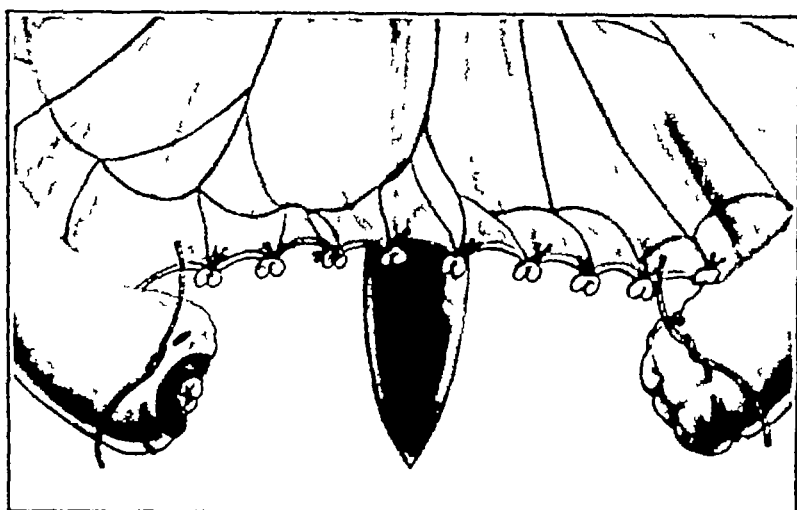


FIG 64.—BARKER'S OPERATION FOR IRREDUCIBLE INTUSSUSCEPTION

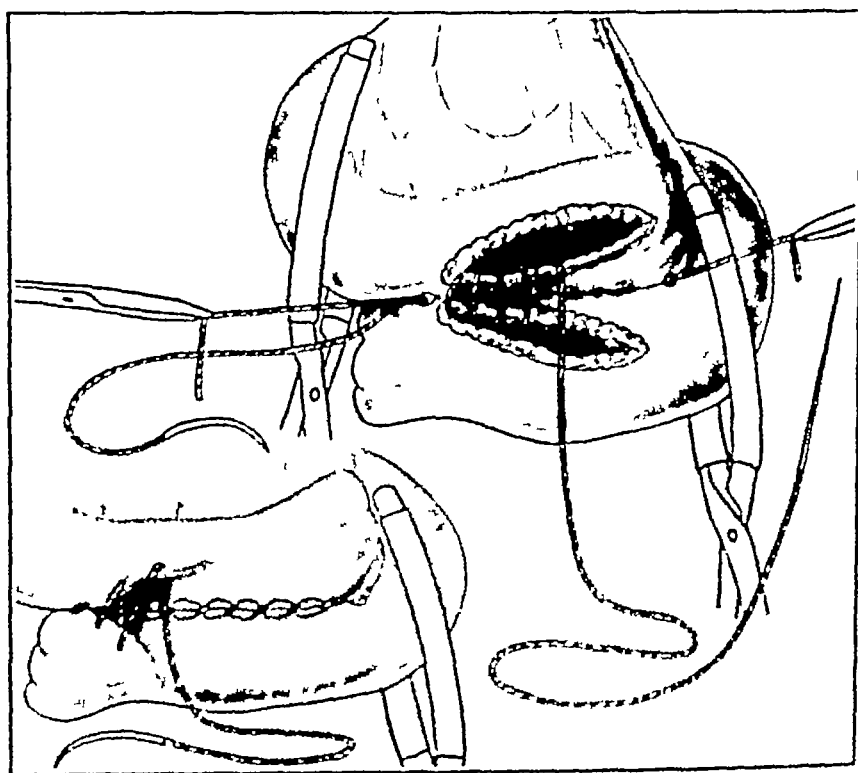
The intussusception is amputated through an incision on the anti mesenteric aspect of the ensheathing layer. The entering and ensheathing layers are united by a few interrupted Lembert sutures.

be a rational procedure and is generally accepted as a sound measure to adopt in irreducible cases.

*Fixation of the Bowel*—Should any attempt be made at operation to anchor the mobile cæcum? Opinions differ on this point and these differences are due largely to the view taken as to the importance in the etiology of the



C



D

FIG. 63 --STEPS OF OPERATION FOR RESECTION AND END TRACHEAL ANASTOMOSIS  
(For description see text.)

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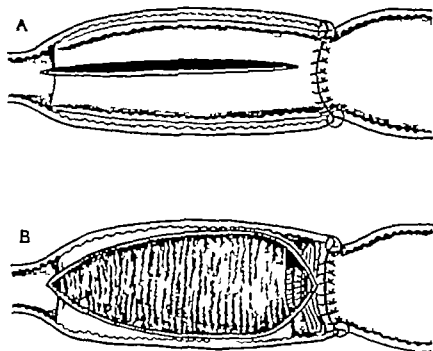


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favourable and the parents may be reassured. On the other hand if operation is not undertaken until the terminal phase is present when the intussusception is found to be irreducible then the outlook is grave the chance of survival being indicated by the published mortality rates of operation at this stage which are between 95 and 100 per cent. Thus a great responsibility rests with both the practitioner and the surgeon in making the diagnosis and it cannot be too strongly urged that in this disease as in acute appendicitis in children a waiting policy must under no circumstances be adopted.

#### RARE TYPES OF INTUSSUSCEPTION

Anomalous forms of acute intussusception may occur. Thus a double intussusception may be present in one child the bowel being affected at two different points. Occasionally an intussusception may start in a Meckel's diverticulum as described in Chapter XII and more rarely still the appendix itself may become intussuscepted. Retrograde intussusception in which the intussusception moves against the direction of peristalsis may occur anywhere in the small bowel but is a condition of extreme rarity. Secondary intussusception—that is intussusception due to a tumour of the bowel—may occur in older children. Cases which have been described in the literature are due to polyps, lipomata or angiomas. Such a tumour may initiate an intussusception directly or give rise to irregularities of muscular action which may in themselves be responsible. Recurrent intussusception is not common and most surgeons can recount only one or two cases of this in their experience. Barrington Ward\* mentions a case in which a recurrence took place three times.

\* Barrington Ward L. E. *The Abdominal Surgery of Children*  
Oxford Med. Publications 1928



tion is usually situated in the small intestine and is frequently of insidious onset. The diagnosis as a rule is not a matter of any great difficulty except perhaps in the very young baby for generally it is known that the child is suffering from tuberculous peritonitis before the complication of obstruction arises. The physical signs and symptoms of the obstruction are characteristic and when fully developed the condition demands surgical intervention. What to do at operation is a problem for in the majority of cases there is no possibility of removing the cause of the obstruction. Occasionally it is conceivable that one may find a single band crossing the intestine and division of this band will be sufficient to release the obstructed loop of bowel but far more frequently the intestine will be so matted together that no direct relief of the obstructed loop will be possible. The feature that one notices first of all on opening the abdomen is the complete absence of the great omentum which is in most cases lifted up into a sausage-shaped mass somewhere in the region of the transverse colon. There will probably be a little free fluid in the abdomen but this is never large in amount since the type of tuberculosis which produces this obstruction is as has already been mentioned of the plastic or dry variety.

There can be no question that it is wise in these cases to limit the operative procedure to the bare necessities demanded by the circumstances and the surgeon should therefore make it his sole purpose to relieve the obstruction without carrying out a detailed exploration of the abdomen to find out the exact point in the intestine at which the obstruction is acting. Great caution must be observed in opening the abdomen of a child suffering from obstruction due to tuberculous peritonitis for the coils of intestine may actually be adherent to the peritoneum of the anterior abdominal wall and may easily be entered in opening the peritoneum. The incision should be below the umbilicus

slightly to the left or right of the mid-line. If the bowel is found to be markedly adherent to the anterior abdominal wall, no attempt should be made to free it widely. A loop of distended bowel is brought up alongside a loop of contracted bowel and a simple lateral anastomosis is all that should be done (Fig. 65). The length of the anastomosis should be generous, to allow of subsequent contraction of the dilated loop. The operation is not without its difficulties. It is inadvisable to attempt to bring the portions

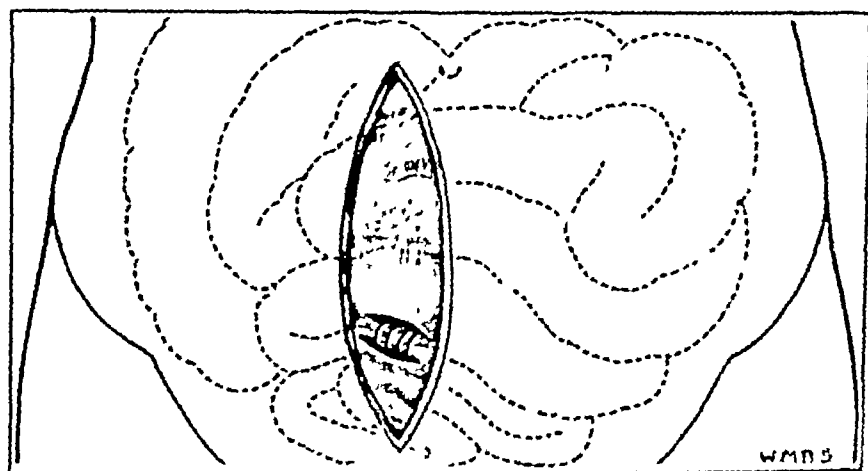


FIG. 65—ACUTE OBSTRUCTION IN TUBERCULOUS PERITONITIS

Lateral anastomosis between a distended and a collapsed loop of small intestine. No attempt is made to free the obstruction by breaking down adhesions.

of bowel to be sutured outside the abdomen. Indeed, this may not be possible owing to the mass of adhesions, and the anastomosis should therefore be done inside the abdomen. The greatest care should be taken to avoid soiling of the peritoneum by the contents of the obstructed bowel, and the parts to be anastomosed must be carefully shut off by moist pads. A light non-crushing clamp should be placed upon the distended loop, both proximal and distal to the intended line of anastomosis, and the bowel contents aspirated away by means of a trocar and carefully

entered through the bowel wall in the intended line of the incision in the bowel. An electric aspirating pump is very useful for this purpose. The first or sero-serous suture should be put in after this has been done otherwise there will be considerable risk of perforating right through the bowel wall with the needle and allowing the thin obstructed

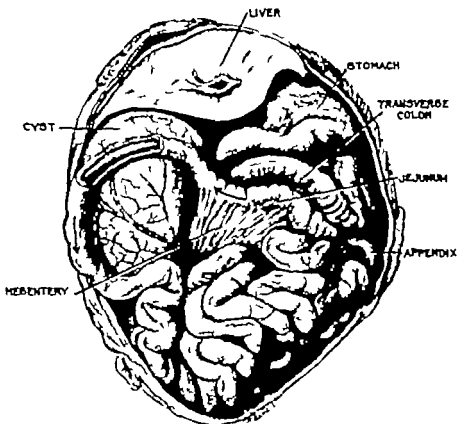


FIG 66—ACUTE INTESTINAL OBSTRUCTION CAUSED BY A MESENTERIC CYST IN AN INFANT SIX DAYS OLD  
(Mr C P G Wakeley's case)

contents to leak through the holes made by the sutures. When the lateral anastomosis is completed the clamps are removed from the obstructed portion of the bowel and the patency of the stoma is tested. It is impossible in view of the fixed position of the great omentum to bring it down round the anastomosis as a protection from the rest of the

abdomen. The question of whether or not drainage should be used is an important one. In view of the tuberculous affection, drainage is clearly undesirable, but if, as a result of an accident of technique, the peritoneum becomes soiled by intestinal contents, then drainage is essential. The prognosis is not good, but the chances of recovery from the operation bear a definite relation to the length of time of operation and to the amount of manipulation that is done.

### **ACUTE OBSTRUCTION FROM OTHER CAUSES**

Though rarer, acute intestinal obstruction from inflammatory bands does not differ in any respect in the child from the adult. New growth as a cause of obstruction to both the large and small bowel is a great rarity. Fig. 66 illustrates a case of acute obstruction due to a mesenteric cyst.

## CHAPTER XII

### CONGENITAL MALFORMATIONS OF THE INTESTINAL TRACT, INCLUDING MECKEL'S DIVERTICULUM

#### CONGENITAL ATRESIA

STENOSIS or complete occlusion may occur at various points in the course of the alimentary canal as a result of congenital malformation. They may be found in the œsophagus the duodenum the jejunum-ileum and most commonly of all at the ano-rectal junction (imperforate anus). The obstruction may be partial or complete. The complete obstructions vary from those in which the lumen is interrupted by a thin diaphragm to those in which the alimentary tube is replaced for a distance by a fibrous cord. Lesser degrees of stenosis may be present throughout life without causing symptoms but complete occlusion excepting that of the extreme distal end of the bowel is incompatible with life and the child dies in the first few days or weeks of infancy.

#### The Œsophagus

Dr C. C. Beatty\* classifies stenosis of the œsophagus into two varieties the membranous type in which there is partial occlusion of the lumen by a fold of normal mucous membrane and a non-membranous type in which there is localised reduction in the size of the œsophagus.

According to Beatty the prognosis in cases of the latter type is practically hopeless but cases of the former type have recovered as a result of treatment by gradual dilatation with bougies controlled by œsophagoscopy until the membrane has been destroyed.

\* Beatty C. C. *Brit Journ Child Diseases* 1928 xxv 237



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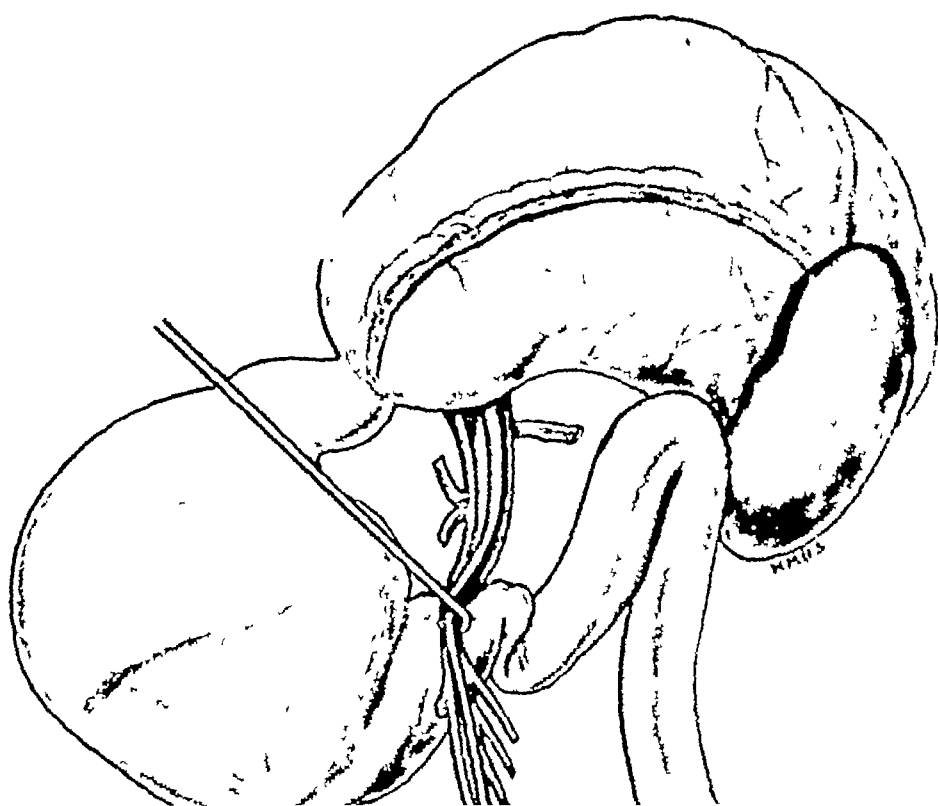
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\* Beatty C. C. *Brit. Journ. Surg.* 1931, 1, 3, xxv 237

### The Duodenum

Probably the most common situation is in the region of the ampulla of Vater, although many cases have been reported at the duodeno-jejunal flexion. Fig. 67 illustrates a case



the ampulla has been displaced as far distally as the crossing of the vessels. The latter have acted as a barrier to further progress. As symptoms in this case did not appear until the child was thirteen months of age and were then of sudden onset it is probable that when the ampulla had migrated as far as the vessels the latter finally determined the onset of complete obstruction.

### The Jejunum and Ileum

The atresia is usually single but may be multiple the bowel being replaced at intervals by an impervious fibrous cord. It is clear that little can be done apart from jejunostomy for this condition and this operation is invariably attended by a fatal issue.

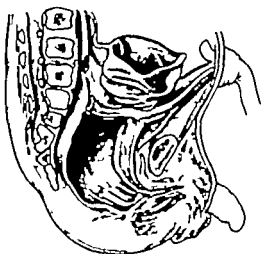


FIG 68 —IMPERFORATE ANUS

The rectum ends blindly at the ano-rectal junction

### The Rectum and Anus

Apart from the condition known as imperforate anus (Fig 68) congenital stenosis of the rectum is very rare. In the one example in our experience stenosis was present at the recto-sigmoidal junction at which situation there was a dense fibrous ring large enough to admit the tip of the index finger.

Despite regular dilatation with bougies, the bowel eventually became acutely obstructed, and a colostomy was performed. The child is now twenty-one months old, and healthy. It is proposed at a later date to excise the structure and close the colostomy.

The diagnosis of imperforate anus is usually made shortly after birth. It is not attended by any acute symptoms, and the child may remain well for many days. Eventually, however, symptoms of bowel obstruction develop.

The condition varies considerably in its pathological anatomy. The anus may be entirely absent, in which case the rectum may open into the bladder or, in the female, into the vagina. In other cases the rectum terminates blindly at the brim of the pelvis. The most common malformation is that in which an anal depression exists, and is shut off from the rectum by a thin membrane. In such cases the bulge of the distended rectum may be noted at the anal depression, especially when the child is crying or straining.

In simple imperforate anus of this type a large trocar and canula should be placed through the anal depression into the rectum, and the meconium allowed to escape. Subsequently the opening thus formed must be regularly dilated to prevent stenosis from cicatricial contraction.

In those cases in which the rectum ends blindly, with no indication of an anal depression, the problem is a far more difficult one. A mid-line incision should be made in the perineum, passing forward from the tip of the coccyx to the central perineal point. The incision should be deepened until the rectum is brought into view. The cul-de-sac is brought as near to the surface as possible and opened on its posterior aspect. A large rubber tube should be sutured into the opening thus made so that a passage for the meconium is maintained. Subsequently frequent dilatation of the resulting fistula is necessary.

If it be found that even after the perineal incision has been deepened to a reasonable limit the rectum cannot be exposed a colostomy should be done without delay

### VOLVULUS NEONATORUM

Volvulus neonatorum is predisposed to by failure of complete rotation of the midgut during development. The arrest of the process of rotation appears to occur most commonly during the second stage so that the cæcum remains a left-sided organ and the entire midgut composed of the distal part of the duodenum the whole of the small intestine and the proximal half of the colon remains suspended from the posterior abdominal wall by a narrow pedicle. Volvulus in which the pedicle becomes twisted is thus a likely occurrence with the result that the whole of the midgut becomes obstructed and its blood supply cut off

Volvulus due to this cause usually affects the child during the first few days of life. It occurs with dramatic suddenness in a child who up to the time of onset appears to be making normal progress

The characteristic features are sudden abdominal pain and vomiting. The abdominal pain as in intussusception is shown by screaming attacks during which the thighs are flexed on to the abdomen. The vomiting increases in frequency and contains bile in considerable quantity but even in the later stages it does not become fæculent

The upper part of the abdomen becomes prominent as a result of extreme distension of the stomach but no tumour can be felt. Constipation is absolute. The infant rapidly becomes dehydrated and the combination of shock resulting from the torsion with the toxæmia of intestinal obstruction soon reduces him to a state of collapse

The diagnosis must be tentative but as Norman Dott\*

\* Dott, Norman *B.M.J.* 1927 1 230

has shown, it can be made preoperatively if the medical attendant is acquainted with the condition.

The treatment is operative, but operation should be delayed for an hour or more in order to give subcutaneous saline and glucose in an effort to restore as far as possible the fluid and carbohydrate loss. The abdomen is opened near the mid-line. The whole of the small gut will be found collapsed and yet blue from venous obstruction, so that the condition may be recognised at sight. The pedicle is untwisted, and the intestines replaced to occupy their normal positions. No attempt should be made at fixation of the intestines, but the surgeon should confine himself to the essential steps necessary to relieve the obstruction.

## EXOMPHALOS

Exomphalos is a condition in which a deficiency persists in the umbilical region of the anterior abdominal wall, so that the child is born with a hernia into the root of the umbilical cord. Varying degrees of the condition may occur, but in its most characteristic form a large hernia is present, covered only by a thin translucent membrane. Volvulus neonatorum due to malrotation of the midgut may coexist, as in the following case:

A male child was brought to the Evelyn Hospital within two hours of birth. Its weight was 5 lb 2 oz. A large hernia was present, with a covering so transparently thin that contents could be plainly seen. Operation was performed with the child under ether anaesthesia. The hernial sac was opened at the junction of the abdominal wall and the sac, and the adherent membrane was separated from the abdominal wall. The contents of the sac were found to be a large, soft, lobulated mass of fat, which was removed. The sac was then closed with a fine suture, and the wound was dressed with iodoform. The child was discharged within 24 hours of the operation, and is now well.

neonatorum) The volvulus was untwisted and the intestine placed with difficulty within the abdominal cavity The thin membrane forming the anterior wall of the hernia was excised and the abdominal wall closed by means of three stout silkworm gut stitches passing through all layers

The patient to my surprise made an uninterrupted recovery and is now a healthy child of four and a half years Apart from a comparatively small incisional hernia which it is intended to repair at a later date the child has an apparently normal abdomen

### MECKEL'S DIVERTICULUM

Meckel's diverticula in their usual form are incapable of giving rise to symptoms They are wide-mouthed their contents are fluid and their complete muscular coat enables them to empty simultaneously with the ileum Some variation in the usual form of Meckel's diverticulum is always present in cases where it is responsible for symptoms Though departures from the usual form are rare variations may occur according to the exact stage reached in the obliteration of the vitello-intestinal duct when that process is arrested In the extreme stage a Meckel's diverticulum may be a patent intestinal tube opening on to the abdominal wall at the umbilicus At the other end of the scale the diverticulum may be the slightest protrusion from the wall of the ileum Fig 69 represents an intermediate stage between these two conditions The diverticulum is of the usual shape but the vitelline veins persist as a fibrous cord running from the mesentery of the ileum to the anterior abdominal wall A horizontal band thus crosses the abdomen and has the same power for evil as a band of inflammatory origin in that the stage is set for axial rotation of coils of small intestine giving rise to acute small intestine obstruction (Fig 70)



has shown, it can be made preoperatively if the medical attendant is acquainted with the condition

The treatment is operative, but operation should be delayed for an hour or more in order to give subcutaneous saline and glucose in an effort to restore as far as possible the fluid and carbohydrate loss. The abdomen is opened near the mid-line. The whole of the small gut will be found collapsed and yet blue from venous obstruction, so that the condition may be recognised at sight. The pedicle is untwisted, and the intestines replaced to occupy their normal positions. No attempt should be made at fixation of the intestines, but the surgeon should confine himself to the essential steps necessary to relieve the obstruction.

### EXOMPHALOS

Exomphalos is a condition in which a deficiency persists in the umbilical region of the anterior abdominal wall, so that the child is born with a hernia into the root of the umbilical cord. Varying degrees of the condition may occur, but in its most characteristic form a large hernia is present, covered only by a thin translucent membrane. Volvulus neonatorum due to malrotation of the midgut may coexist, as in the following case.

A male child was brought to the Evelina Hospital within two hours of birth. Its weight was 5 lb 2 oz. A large hernia was present, with a covering so transparently thin that coils of small intestine could be plainly seen. Operation was undertaken within five hours of birth, under ether anaesthesia. The hernia was opened at the junction of the membrane and the skin. A broad adhesion was present between the jejunum and the covering of the hernia (? persistence of a ventral mesentery). The whole of the midgut lay within the sac, and was collapsed and cyanosed as a result of a twist of its narrow pedicle through 180° (volvulus

neonatorum) The volvulus was untwisted and the intestine placed with difficulty within the abdominal cavity. The thin membrane forming the anterior wall of the hernia was excised, and the abdominal wall closed by means of three stout silkworm gut stitches passing through all layers.

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Meckel's diverticula in their usual form are incapable of giving rise to symptoms. They are wide-mouthed, their contents are fluid, and their complete muscular coat enables them to empty simultaneously with the ileum. Some variation in the usual form of Meckel's diverticulum is always present in cases where it is responsible for symptoms. Though departures from the usual form are rare, variations may occur according to the exact stage reached in the obliteration of the vitello-intestinal duct when that process is arrested. In the extreme stage a Meckel's diverticulum may be a patent intestinal tube opening on to the abdominal wall at the umbilicus. At the other end of the scale the diverticulum may be the slightest protrusion from the wall of the ileum. Fig. 69 represents an intermediate stage between these two conditions. The diverticulum is of the usual shape, but the vitelline veins persist as a fibrous cord running from the mesentery of the ileum to the anterior abdominal wall. A horizontal band thus crosses the abdomen and has the same power for evil as a band of inflammatory origin, in that the stage is set for axial rotation of coils of small intestine giving rise to acute small intestine obstruction (Fig. 70).

A second way in which a Meckel's diverticulum may be responsible for symptoms is through the occurrence in its wall of epithelium foreign to that part of the intestine from which it opens—misplacement of epithelium, or epithelial heterotopia

Both gastric and pancreatic epithelium may be found, and in both cases the epithelial cells are of normal healthy

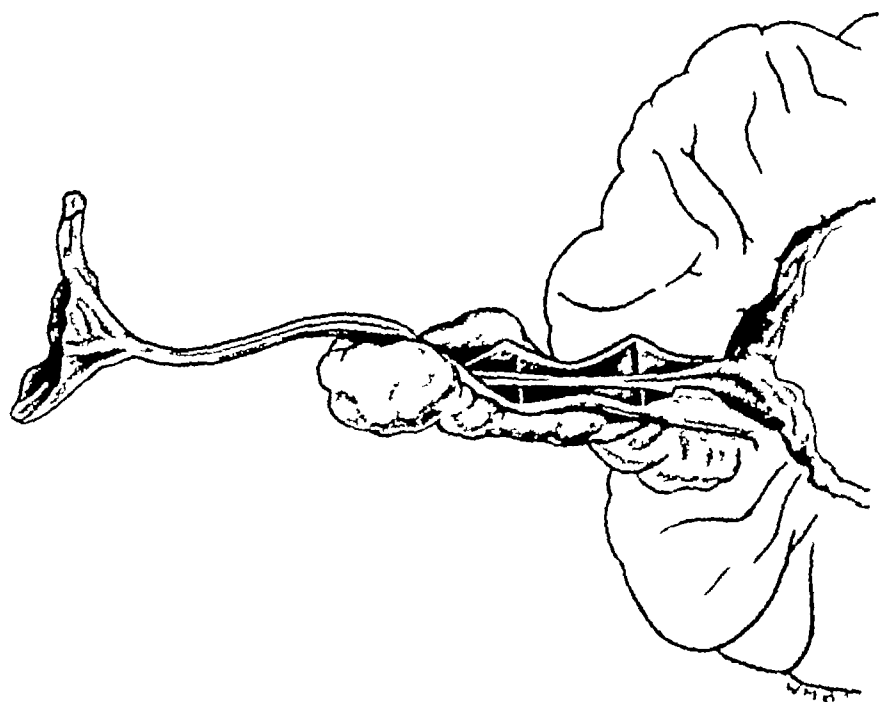


FIG 69 — MECKEL'S DIVERTICULUM, WITH PERSISTENCE OF A PORTION OF THE OMPHALO-MESENTERIC DUCT AND VITELLINE VEINS, BY WHICH THE DIVERTICULUM IS ATTACHED TO THE ANTERIOR ABDOMINAL WALL

Such a condition predisposes to acute obstruction

appearance and functionally active. In the case of gastric heterotopia the cells may occur in patches in the otherwise normal mucosa, or may form a complete epithelial lining to the diverticulum, lying deep to a layer of intestinal epithelium. The clinical significance of this anomaly lies in that the mucosa of the diverticulum is constantly bathed in

a highly acid secretion and that a typical peptic ulcer may result similar in its morbid anatomy to peptic ulcers of the stomach and prone to the latter's two complications of perforation and hæmorrhage

In pancreatic heterotopia the pancreatic tissue is usually clumped together to form a nodule in the wall of the diverticulum at or near its blind end. Gastric epithelium may also be disposed in this way. The existence of such a

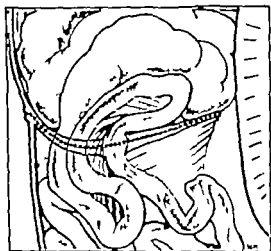


FIG. 70.—ACUTE INTESTINAL OBSTRUCTION (MR H. L. C. WOOD'S CASE) RESULTING FROM A CONDITION SIMILAR TO THAT ILLUSTRATED IN FIG. 69

Note that a complete band traverses the abdomen consisting of mesentery and Meckel's diverticulum. The diagram represents the condition found at operation upon an actual case.

nodular mass is apt to predispose to intussusception of the diverticulum and thus cause intestinal obstruction. In two recent cases of intussusception in boys of four and ten years respectively a Meckel's diverticulum which itself had intussuscepted was found to be the cause. In the one case a pancreatic nodule was found in the diverticulum and in the second a mass of gastric epithelium (Figs 71 and 72).

Meckel's diverticulum may thus be responsible for acute obstruction, perforation, and hæmorrhage

In acute obstruction cases the diagnosis of a Meckel's diverticulum cannot be made with certainty, but it should be borne in mind in cases of acute obstruction in children

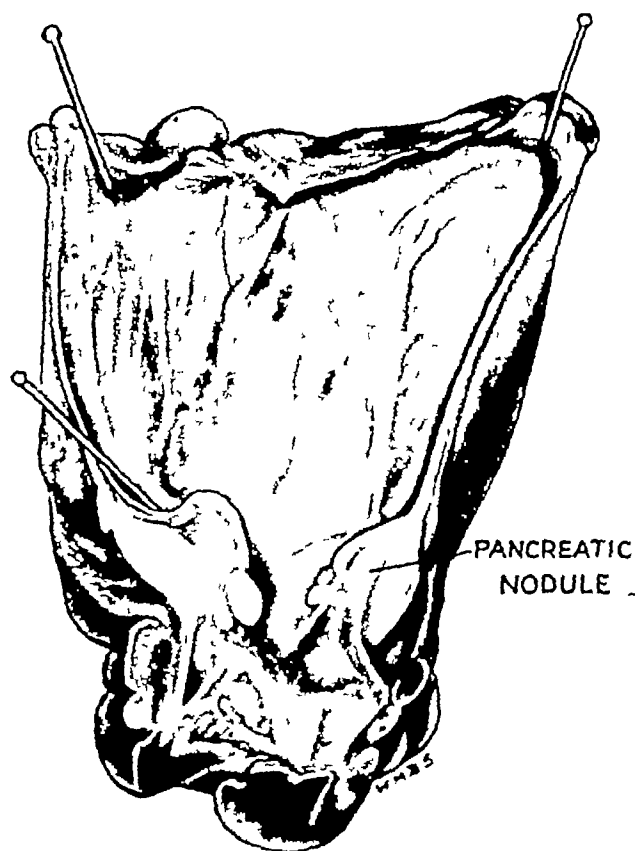


FIG 71 —A MECKEL'S DIVERTICULUM WHICH HAD INITIATED AN ACUTE INTUSSUSCEPTION

At its apex is a nodule of normal pancreatic epithelium

when intussusception and inflammatory conditions can be excluded. As in all cases of intestinal obstruction, the treatment is immediate laparotomy. In those cases where the diverticulum forms a band across the abdomen, it should be clamped and divided at both ends, and the intestinal end buried by a purse-string suture in the ileum, after the usual

manner employed in burying the stump of the appendix in appendicectomy. A simple ligature around the distal end should suffice.

When a Meckel's diverticulum is revealed during the reduction of an ileo-ileal intussusception as in the two cases men-

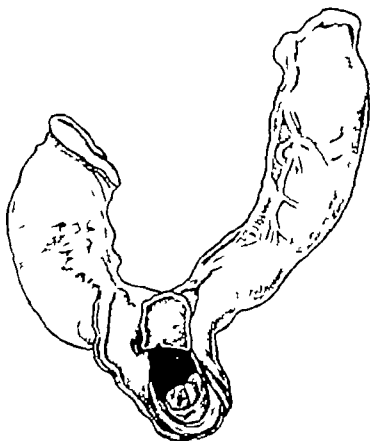


FIG. 72.—A MECKEL'S DIVERTICULUM WHICH HAD INITIATED AN ACUTE INTUSSUSCEPTION.

It is itself partly intussuscepted. The mass at its free end is composed of normal gastric epithelium.

tioned the diverticulum is cut away from the bowel and the latter repaired by stitching up the wound in the transverse axis of the bowel to minimise the danger of narrowing of the lumen. The diverticulum in these intussusception cases is too swollen from congestion to permit



## CHAPTER XIII

### THE THORAX

#### ACUTE EMPYEMA THORACIS

THE essential feature of empyema is the presence of pus in the pleural cavity and pneumonia is almost invariably the underlying cause. The infection may spread from the lung into the pleural cavity during the acute phase of the pneumonia (*synpneumonic*) but more commonly it develops after the pneumonia has commenced to resolve (*metapneumonic*) and appears sometimes during the first week after the crisis. The *synpneumonic* type is naturally a far more serious condition than the *metapneumonic* for it occurs at a time when the patient is at the height of the toxæmia. The lung is partly or completely consolidated and there is little chance for the infection to be isolated within the pleural sac so that it exists as a diffuse purulent pleurisy.

A further classification of empyema may be made according to the nature of the infecting organisms which in children are practically limited to the pneumococcus and the streptococcus. In *pneumococcal* empyema the pleura is covered with a fibro-purulent mass and adhesions between its visceral and parietal layers are readily formed so that at an early date the abscess is shut off from the general pleural cavity. The pus in the early stages of *streptococcal* infection is a thin slightly turbid fluid which may be bloodstained. The infection in the pleural cavity is a diffuse one and there is at first little tendency to the formation of adhesions which would localise the infection. *Pneumococcal* empyema is



almost invariably of the metapneumonic type and occurs, therefore, when the patient has overcome the toxæmia of the pneumonia and the lung is beginning to expand. In streptococcal empyema, however, the infection is commonly of the synpneumonic type. Thus it is readily understood that streptococcal empyemata will carry a far graver prognosis than those of the pneumococcal type. Recent statistics of cases in which modern treatment was carried out show that the mortality in pneumococcal cases was 17.5 per cent. in 285 patients and in streptococcal cases 34 per cent. in 88 patients\*. In the pneumococcal type the organism is usually Type I.

The pus in empyema usually collects at the lower aspect of the pleural cavity. Rarely an abscess may form near the apex of the lung (*apical empyema*) or between two lobes of the lung (*interlobar empyema*) or between the lung and the diaphragm (*diaphragmatic empyema*).

### Diagnosis

The early signs and symptoms in empyema are those of an effusion of fluid into the pleural cavity. Pain in the side is usual, but may not be a marked symptom, and, in the synpneumonic type, may fail to attract special attention owing to pain arising from the coexisting pneumonia. Dyspnoea, due to compression of the lung and also to a certain extent to alteration in position of the mediastinal structures, may follow. The pulse rate is increased and there is pyrexia. The mobility of the chest wall in the affected side is reduced. As the size of the collection increases there may be bulging of the intercostal spaces. There is dullness to percussion over the base of the lung, and breath sounds and vocal resonance are diminished. Bronchial breathing may

be noted in the lung above the collection and an area of increased vocal resonance may be detected together with the tympanitic note described as skodaic resonance. The apex beat will be displaced to the side opposite to the affected one the degree of displacement corresponding to the size of the effusion.

*Exploration of the chest with a needle* should be made as soon as the presence of an empyema is suspected and the nature of the fluid withdrawn noted and cultures made.

Radiological examination is of immense value in doubtful cases especially in those in which the empyema is atypical e.g. apical empyema and diaphragmatic empyema. In these cases radiological examination should precede exploration of the chest with a needle.

### Principles of Treatment

Although empyema thoracis is included within the scope of this book it should not be regarded as an emergency in the strict sense of the word. A clearer understanding of the pathological anatomy has led to the abandonment of the one-time practice of operating in all cases as soon as the diagnosis is made. This practice of delay in operating upon empyema does not abrogate the surgical rule of early free drainage of a localised abscess cavity but rather entails a stricter observance of it. For before operation is undertaken the collection of pus inside the pleural cavity must be localised—that is to say walled off from the general pleural cavity by inflammatory adhesions between the visceral and parietal layers of the pleura. If the pleural cavity is opened before such adhesions have formed the effect of the rapid changes of pressure created within the thorax by operation will give rise to considerable and rapid movement of the mediastinum a contingency which is ill tolerated in the patient suffering from the degree of toxæmia

which generally accompanies empyema in its acute form. This is more than ever true in the young infant, in whom too early operation is to be rigidly avoided, for it may be directly responsible for a fatal issue. When adhesions have formed, displacement of the mediastinum at operation is reduced to a minimum, and far less disturbance is thus created when the pleural cavity is opened.

It is thus clear that whereas in the pneumococcal type of infection surgical drainage may be employed with advantage at an early date, in the streptococcal cases it must be avoided and the condition treated by repeated aspiration until such time as the pus commences to thicken. This will usually correspond with a fall in the temperature and with the formation of adhesions localising the abscess. In a certain proportion of streptococcal cases recovery takes place after treatment by aspiration alone, but this is unusual. It is of the greatest importance not to postpone drainage for too long a period. In pneumococcal cases repeated aspiration should also be practised in preference to early drainage when the empyema is of the synpneumonic type, and in infants, in whom the mortality from empyema is high. In bilateral cases drainage should be in the first instance performed on one side only, the other side being treated by aspiration.

**Technique of Aspiration.**—One of the great disadvantages of repeated aspiration is that the superficial layers of the chest wall may become infected, with resulting cellulitis. This danger may be overcome if, under a local anaesthetic, an incision be made through the skin at the site intended for aspiration, and the wound left open and dressed with sterile vaselinised gauze. Later this same incision may be used for rib resection, should this become necessary.

The needle should be some three to four inches long and of wide bore. An ordinary 20 c.c. syringe may be used, but it is a great advantage to have a two-way syringe, as the obvi-

the necessity for detaching the latter from the needle to empty it and makes the whole operation much cleaner and more rapid

The greatest care must be exercised in introducing the needle so that it is not pushed in too far and the lung or the diaphragm injured. Except when the pleural cavity is distended with the exudate and there is great displacement of the heart and mediastinum it will be safe to empty the cavity completely. In the former event the fluid must be withdrawn slowly and at intervals so that the decompression is not too rapid

#### OPERATION FOR DRAINAGE

Serious differences of opinion exist as to whether drainage in empyema should be achieved by the open or the closed method. The use of both methods in different cases over a considerable period has led me to the conclusion that the essential of treatment is the provision of *free* drainage. With this proviso the immediate and the remote results of operation are determined more by the attention given to each individual case in the post-operative period than by the actual method of obtaining this free drainage. Thus once the attendant is satisfied that the pus is localised he has a choice of either method. The exception to the rule is in the case of small infants and in these closed drainage without rib resection is unquestionably preferable to the major operation

The important factors therefore are correct timing of operation free drainage attention to post-operative detail.

#### Operative Technique

**Open Method.**—In the usual type of basal empyema a portion of the eighth or ninth rib is removed in the posterior axillary line. This may be done under a local anæsthetic

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The important factors therefore are correct timing of operation, free drainage, attention to post-operative detail.

### Operative Technique

**Open Method.**—In the usual type of basal empyema a portion of the eighth or ninth rib is removed in the posterior axillary line. This may be done under a local anaesthetic

provided the greatest care is taken to ensure infiltration of all the structures to be divided. The greatest difficulty arises in connection with the periosteum on the deep surface of the rib to be resected, and it is necessary to infiltrate the subcostal nerve of the rib above and below. For the average case gas and oxygen anæsthesia is the most convenient. The patient should lie on the operating table in the semi-recumbent position with the affected side overlapping the edge of the table. The arm on this side is grasped by an assistant standing on the other side of the table so as to raise the shoulder (Fig. 73). It is a wise precaution for the

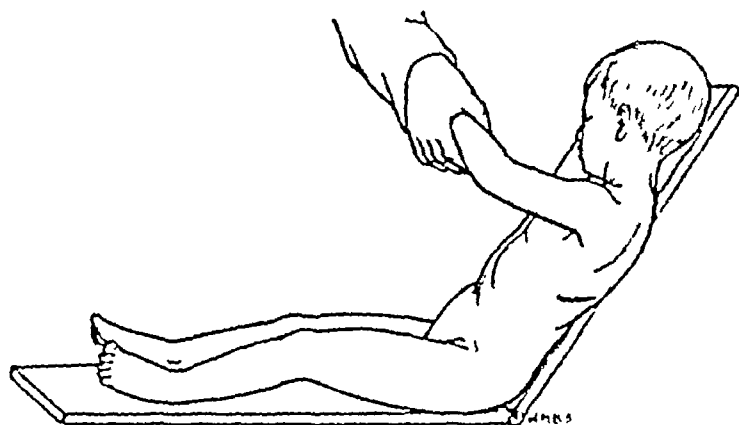


FIG. 73.—DIAGRAM TO SHOW POSITION OF THE CHILD ON THE OPERATING TABLE FOR THE OPERATION OF RIB RESECTION.

surgeon, if not himself responsible for the pre-operative exploration, to explore the chest with a needle before making the incision.

The incision passes through the skin and muscles over the rib to be resected. There will be some bleeding from small vessels when the muscles are divided and the *cl* are taken in Spencer Wells. Unless the vessel is of considerable size ligatures should be avoided. The periosteum is incised and raised from the rib over a distance of two inches by means of a rongeur. The periosteum on the deep aspect of the rib is separated by means of a Boylston's scissor.

(Fig 74C) The trough created by the removal of the rib consists of periosteum and the parietal pleura and the empyema is opened by incising along it. The incision should be only

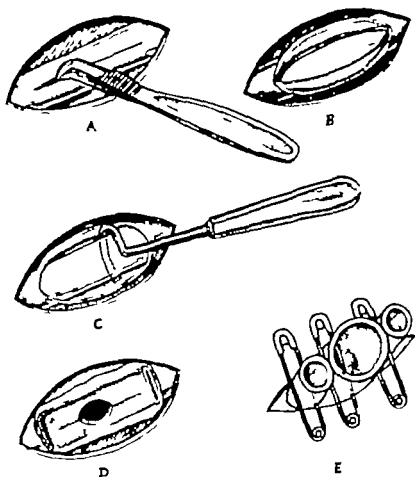


FIG 74—RESECTION OF RIB FOR EMPYEMA

A and B incision of periosteum on the outer surface of the rib and its reflection with a rongeur. C separation of the periosteum from the deep surface of the rib. D incision of the deep layer of periosteum and pleura. A small opening is first made which is subsequently enlarged. E drainage tubes in position at the completion of the operation.

large enough in the first instance to admit one finger and the pus allowed to escape past the finger slowly so that no sudden alteration in the intrathoracic pressure is allowed to occur. In pneumococcal empyema the pus is of variable



consistency and large masses of coagulated purulent lymph are found. When the majority of the thinner fluid has escaped, the incision in the pleura is increased and the more solid masses are evacuated. This can be aided by very gentle aspiration with a mechanical suction apparatus, or by gently wiping the pleural walls with a finger covered in a layer of gauze, or with a sponge-holding forceps containing a gauze swab. Whichever method is employed, the utmost gentleness should be used so that there is no danger of breaking down any adhesions. In favourable cases in which the pneumonia has resolved, the lung will be seen to expand and partly obliterate the empyema cavity.

The wound is left widely open and no attempt is made to suture the muscle layers. One large and two smaller tubes are placed in position so that they project a distance of a quarter to a half inch only into the pleural cavity. Each tube must be transfixed by a large safety-pin passing through it at right angles to the wound to ensure against its being aspirated into the cavity. A dressing is now applied, and in my opinion it is imperative that an antiseptic should be used, for the success of this operation depends very largely upon the avoidance of secondary infection, to which an antiseptic such as 1/40 carbolic forms an effective barrier. A copious dressing should be used, economy in this is strongly to be deprecated. The dressing is kept in place by a many-tailed bandage with shoulder straps and is changed six-hourly for the next two or three days. It is important not to wait until the dressing "comes through" before it is changed. Irrigation of the cavity with Dakin's solution or other antiseptic is not recommended for routine use in pneumococcal empyema in children. The tubes remain in position, as a rule, for a period of four or five days, and may then be removed completely or replaced by a single tube for a day. It is hardly necessary to state the danger of aspirating the tube into the

cavity but the importance of this must be realised in hospital practice where nurses are undergoing training

**Closed Method.**—The essential feature of the closed method is continuous aspiration of the exudate through a large tube without creating a pneumothorax. The disadvantage of the method for routine use is that *free* drainage is difficult to obtain and thus many of the cases on whom it is used will need open drainage at a later date. The number of secondary operations is however diminishing as our experience of closed drainage increases. It is undoubtedly the method of choice for empyemata in infants and may be used in place of repeated aspiration in syn pneumonic and streptococcal empyemata in which the pus will be sufficiently thin not to cause blockage of the tube

Many ingenious operations have been devised for closed drainage. In their inventor's hands these operations appear to have given satisfactory results but in my opinion it is

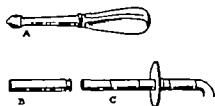


FIG 75—EMPYEMA CLOSED METHOD OF DRAINAGE

A=trocar B=canula C=graduated rubber tube which fits the canula B and on which is a movable rubber flange

far safer to use a simple technique such as the following

A medium-size trocar and canula are required and a rubber tube which is the largest that can be passed through the canula. The tube should be marked out in inches (Fig 75). The area selected is infiltrated with 0.5 per cent. novocaine and a small incision is made through the skin over an intercostal space as far as the intercostal muscles. The trocar and canula are passed through the intercostal space into the pleural cavity. If the ribs are too close together one inch or so of rib should be resected, and the trocar and canula passed through its bed. The trocar is now withdrawn and the rubber tube quickly passed through the

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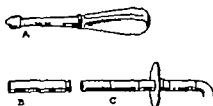


FIG 75 — EMPYEMA CLOSED METHOD OF DRAINAGE

A=trocar B=canula C=graduated rubber tube which fits the canula B and on which is a movable rubber flange

canula into the cavity. It should be clamped so that no air is allowed to enter. The canula is now removed over the tube, which is again clamped. The tube is withdrawn until it projects not more than one inch into the pleural cavity, and it is fixed in this position by means of a perforated rubber flange and adhesive strapping.

The tube is connected to a simple water pump, such as the one described by Poynton and Reynolds\* (Fig 76)

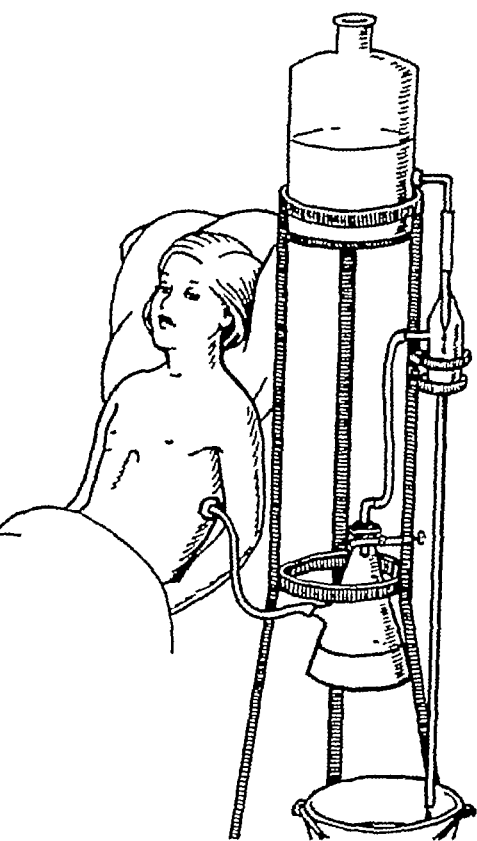


FIG 76 —CLOSED DRAINAGE OF AN EMPYEMA

Continuous drainage apparatus  
(after Poynton and Reynolds)

### Post-Operative Care

The ultimate result depends upon the ability of the lung to expand and fill up the empyema cavity, for the latter is incapable of collapsing of its own accord owing to its rigid walls. It is unusual in children, provided adequate care is taken in the post-operative period, for there to be any delay in healing in the ordinary type of basal empyema. The sinus

is on an average dry in three weeks and completely healed in five. As the expansion of the lung is depended upon to obliterate the cavity, any measure calculated to aid it must be employed. Unquestionably the most important is deep breathing exercises with the lung on the sound side.

\* Poynton, F. J., and Reynolds, F. N., *Lancet*, 1921, ii, 1100.

strapped and these should be practised as soon as the tubes have been removed if the child is old enough to be instructed. The usefulness of blowing through Wolff's bottles is very doubtful although in young children it provides an amusing exercise especially if the water be coloured.

Textbooks on surgery must be consulted for a full description of the various causes of chronic empyema following acute but mention must be made of errors in technique which may predispose to delay in the healing of the empyema wound. The two most important are inadequate drainage and secondary infection. With reference to the former it is important that drainage by the closed method should not be persevered with if any difficulty arises such as clogging of the aspirating tube by the exudate and with regard to the latter the use of an abundant dressing together with a suitable antiseptic is the best precaution against infection entering the wound from outside.

### ACUTE SUPPURATIVE PERICARDITIS

This condition most commonly complicates acute staphylococcal osteomyelitis and the prognosis is an extremely grave one. The mortality in cases untreated surgically is 100 per cent. Occasionally a life can be saved if the diagnosis be made at a sufficiently early date and the pericardium opened and drained. The diagnosis which is largely a medical question is confirmed by exploratory puncture. Under local anaesthesia the exploratory puncture is made in the angle between the ribs and the xiphisternum on the left side the patient being in a sitting position. The needle is passed upwards and backwards and a little to the left (Fig. 77). After it has penetrated through the skin and muscles aspiration should be attempted for the rest of its journey so that immediately it has entered the pericardial sac pus will be drawn into the syringe. It is







hæmopneumothorax will form, and the patient may even bleed to death into the pleural cavity. In the great majority of cases in which a hæmothorax of any size develops, the child usually has received such severe injuries elsewhere in the body that very little can be done for him.

If the effusion of blood into the pleural cavity is a large one, there should be no hesitation in aspirating it. In cases in which loss of blood is severe and continued, exploration of the pleural sac must be considered. A long incision is made below what is considered to be the point of injury to the lung and an intercostal space is incised or a rib is resected and the pleura opened. The edges of the wound are widely retracted so that the underlying lung can be exposed. If a portion of the lung be extensively lacerated, an attempt at ligation *en bloc* of the damaged area may be attempted, as suggested by Fèvre, or, alternatively, the bleeding controlled by the pressure of gauze packing.

### MASTITIS

Acute inflammation of the breast may occur in the newborn child and also at puberty. The condition almost always subsides without any form of treatment, but resolution is helped in the more acute types by hot fomentations. Though resolution is the rule, suppuration occasionally occurs, even in mastitis of the newborn, in which case drainage will be necessary.

## CHAPTER XIV

### I THE URINARY TRACT

ACUTE pyelitis is a condition of very great importance to the emergency surgeon on account of the possibility of confusing it with acute appendicitis. The essential points in the differential diagnosis between the two are enumerated on p 123.

Acute retention of urine is practically unknown in the female child. In boys its usual cause is a congenital narrowing of the external urinary meatus associated with phimosis. Phimosis *per se* rarely gives rise to urinary obstruction. Hence when the operation of circumcision is performed in children in whom there is evidence of difficulty in micturition it is essential to test the normal patency of the anterior urethra at operation by means of a probe. Should narrowing of the external meatus be present it should be enlarged by incising the glans backwards from the posterior lip of the meatus in the mid line. What little bleeding occurs is readily controlled by pressure with gauze wrung out in hot saline.

Chronic obstruction to the passage of urine may occur in the male child as the result of a congenital valve formation in the floor of the prostatic urethra. Such cases do not as a rule demand urgent surgical measures for their relief.

#### PERINEPHRIC ABSCESS

Perinephric abscess results from infection of the cellular tissue surrounding the kidney. In the majority of cases the infection is blood borne and not due to any pre-existing

disease of the kidney itself. It is not clear whether the infection is carried direct to the perirenal cellular tissue, or to the cortex of the kidney, in which event a small abscess is formed which ruptures into the perinephric tissue. The fact that it is unusual to find pus in the urine cannot be held as evidence against infection of the cortex, as the abscess which forms ruptures into the perirenal tissue and not into the renal tubules.

In almost every instance the causal organism is the *Staphylococcus aureus*. In some cases injury may be a predisposing cause.

The condition varies considerably in its severity. It may be of acute onset and accompanied by a high temperature and a marked leucocytosis, or, on the other hand, of insidious onset and may run a practically afebrile course.

In acute cases pain is a marked feature, although accurate localisation to the lumbar region may not be present. There is marked tenderness over the kidney, and the overlying muscles are rigidly contracted. Movements of the spine are limited and painful, and there may be a fixed kyphosis in the dorsi-lumbar region. For this reason the condition has not infrequently been mistaken for osteomyelitis of the spine. A valuable and constant sign is flexion of the hip-joint on the affected side due to spasm of the psoas muscle.

There may be little or no swelling in the initial stages, but, as the condition progresses, a fullness appears in the lumbar region, and this is best appreciated by examining the sitting child from above and making a comparison of two sides of the body (Fig. 79). The overlying skin may be slightly œdematous.

### **Treatment**

In the early stages fomentations should be applied until a recognisable swelling appears in the loin. Operation should then be performed. The patient is placed on the

unaffected side with the knees flexed. An oblique incision is made commencing just below the junction between the erector spinæ muscle and the last rib and passing downwards and forwards towards a point above the anterior superior iliac spine. The incision need not be as long as that usually required for exposure of the kidney but long enough to enable the various coverings of the kidney to be recognised.

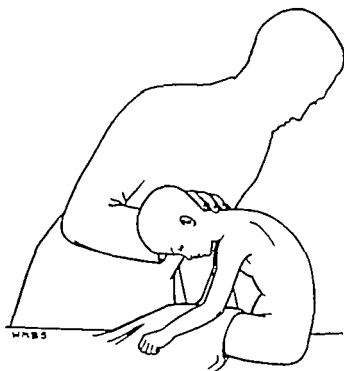


FIG. 79.—METHOD OF EXAMINING THE PATIENT FOR SUSPECTED PERINEPHRIC ABSCESS.

The latissimus dorsi, the external and internal oblique muscles and the transversalis muscle are incised. These will readily be recognised because of the œdema present. The perinephric tissue is picked up in forceps and incised. Especial care should be taken not to injure the peritoneum which lies at the lower angle of the wound. If the abscess be a large one the peritoneum will be pushed away out of danger but in other cases it must be avoided by opening

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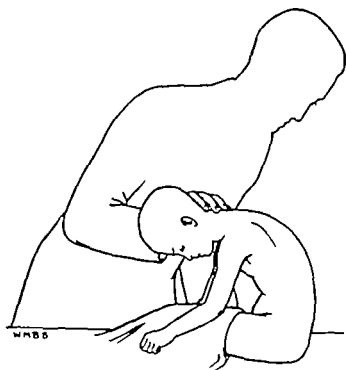


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the perinephric tissue at the upper angle of the incision. The abscess cavity is fully opened and a large drainage tube inserted.

In the insidious type of case the condition may readily be missed until the abscess has grown to a considerable size. Beyond general malaise there may be no obvious indications of disease, and the temperature may not rise above 99°. Psoas flexion is usual, however, even though less in degree than in acute cases. The swelling is most easily recognisable by inspection of the child's back from above. As in acute cases the treatment is operative.

In both the acute and more chronic variety the prognosis after operation is excellent.

## II. THE GENITAL TRACT

In the female child torsion of an ovary enlarged as a result of a new formation such as a dermoid is very occasionally encountered. In one such case in a child of two years an enlarged ovary which had undergone torsion proved on section to be a teratoma.

The symptoms which accompany torsion are those of low abdominal pain and sickness. There is no true rigidity of the muscles, and on rectal examination it may be possible to detect an abnormal swelling. In the majority of cases of this rare condition the pre-operative diagnosis will be that of appendicitis, particularly in those in whom the right ovary is the one affected. The error is of no very great importance, for in both conditions the desideratum is immediate operation.

### ACUTE SALPINGITIS: PYOSALPINX

The importance of this very rare condition lies in its relation to primary peritonitis (p. 98).

## TORSION OF THE TESTIS

By torsion of the testis is meant that condition in which the blood supply of the testis is impeded as a result of volvulus (Fig 80). Torsion of the testis is of course a misstatement of pathology as the torsion actually occurs not in the testis but in the spermatic cord or in the attachment between the testis and the epididymis. In children the latter is far the more common of the two. The predisposing cause is an abnormally long attachment between the testis and the epididymis (the mesorchium) which occasions an unusual mobility of the testis upon the epididymis. The mesorchium is often unusually long in imperfectly descended testis hence it is that torsion is more common in the imperfectly descended than in the fully descended testis. The torsion takes place within the tunica vaginalis and thus differs from cases of torsion of the spermatic cord itself in which the tunica vaginalis is involved.



FIG 80.—TORSION OF THE TESTIS

In this case the epididymis is also involved

The condition is characterised by an extremely sudden onset of acute pain in the testis with referred pain in the corresponding side of the lower abdomen. Vomiting accompanies the pain and there may be severe prostration and abdominal distension. On examination the testis is found to be swollen and tender. If the testis is descended the swelling appears in the inguinal region thus both the symptoms and the physical signs resemble those of strangulation of an inguinal hernia. The similarity may be so close that the differential diagnosis may be extremely difficult but as operation is



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taken at once in either condition it is of little import. The torsion completely occludes the veins, but the arteries may escape in the early stages. The testis is thus very greatly distended and is discoloured. As a result of this interference with its blood supply the testis very rapidly degenerates, and there is little prospect of its recovery even if operation should be undertaken within a few hours after torsion has occurred. Although the swelling is at first confined to the testis itself, œdema of the corresponding half of the scrotum develops at an early date in cases where the testis is fully descended.

Whether the testis be in the inguinal canal or in the scrotum, an incision should be made over the inguinal region as for a hernia operation. The tunica vaginalis is opened and the testis examined. Except when the twist has been only a partial one and operation has been undertaken soon after the onset of symptoms, the testis will show no signs of recovery after the volvulus has been undone. Orchidectomy should therefore be performed.

### **ACUTE ORCHITIS**

Mumps is practically the only cause of acute orchitis in children, other than the obvious one of trauma. In mumps swelling of the testis usually follows the parotid enlargements, but on occasion it is the only manifestation of the disease. It is usually, though not invariably, bilateral, and can be distinguished from torsion by the less sudden onset and by the absence of abdominal pain and sickness.

### **ACUTE IDIOPATHIC ŒDEMA OF THE SCROTUM**

This term was formerly applied to a condition in which the scrotum in the young child became painful and œdematous. It is now believed that the cause is thrombosis of the testicular artery, and the treatment is non-operative.

## CHAPTER XV

### THE EAR, NOSE AND THROAT

(BY GEOFFREY H. BATEMAN F.R.C.S.)

A SURGICAL emergency in the ear nose or throat is often difficult to diagnose for suspicious symptoms may arise in the absence of any pathological condition and more frequently particularly in infants an ear nose or throat emergency may exist without manifesting symptoms directly referable to the diseased organ. One cannot therefore overemphasise the importance of thoroughness and efficiency in the examination of the ear nose and throat in children. Unless conducted under the best possible conditions this may be extremely difficult.

Vision is best obtained by artificial lighting in a darkened room. This is essential for examining a nose or ear and desirable in a throat case. The surgeon may use a head mirror, a head lamp or an electric auriscope or rhinoscope for each has its advantages.

The head mirror gives the best light without shadows or distortion. A source of light preferably an electric light is placed behind the patient's left shoulder. The patient's face and ears are thus in shadow except for the beam of light directed from the surgeon's concave frontal mirror on to the part being examined which is thus the most brilliantly illuminated part and the surgeon's eyes are protected from the glare of the lamp by the mirror worn over the right eye. The disadvantage of the frontal mirror is that when the surgeon moves his head he must readjust the mirror and there is difficulty when the examination must be made away from the consulting room in getting the source of light held in the right place.

The head lamp produces more shadows than the head mirror, and a battery has to be carried with it, but the light moves with the surgeon and does not require readjustment, so that in this respect it is of advantage in examining a struggling child

The electric auriscope is very easily portable, and the light moves with the instrument. It is therefore the easiest method of getting the light directed on to the part to be examined, although the battery in the handle makes the instrument clumsy to use. The vision is apt to be distorted—that is to say, it appears different from the same object as seen with a head mirror or lamp. The lamp in the auriscope makes the use of instruments more difficult, and sterilisation is unsatisfactory because of the handle and bulbs

For consulting room use, therefore, the head mirror is probably the most satisfactory, when the patient must be examined in bed or in his own home, a head lamp is more convenient

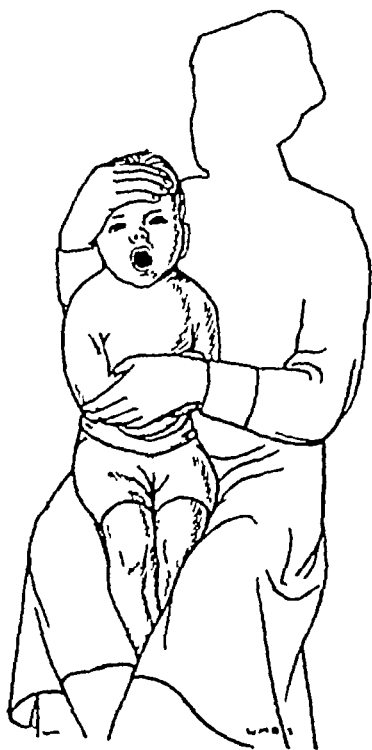


FIG 81 —METHOD OF HOLDING A CHILD FOR EXAMINATION OF THE NOSE AND THROAT

### EXAMINATION OF THE THROAT AND NOSE

The patient is seated on the knee of an adult with his legs gripped between the legs of the adult. The left hand holds both the child's hands in front of his body and the right hand is placed on the child's forehead and holds his head still and tilted backwards (Fig. 81). In this position the nose and throat can be examined comfortably. Older children can be

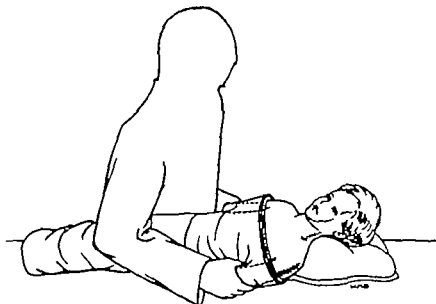


FIG 82 —METHOD OF HOLDING A CHILD FOR EXAMINATION OF THE EAR

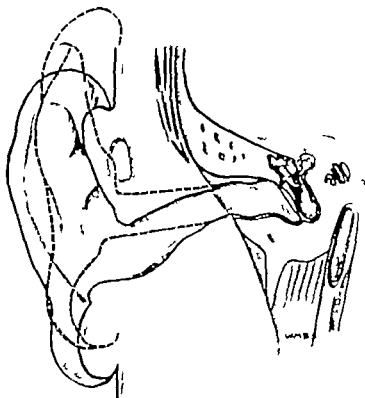


FIG 83 —SECTION OF THE RIGHT EAR TO ILLUSTRATE THE NECESSITY FOR PULLING THE EAR UPWARDS AND BACKWARDS DURING OTOSCOPY

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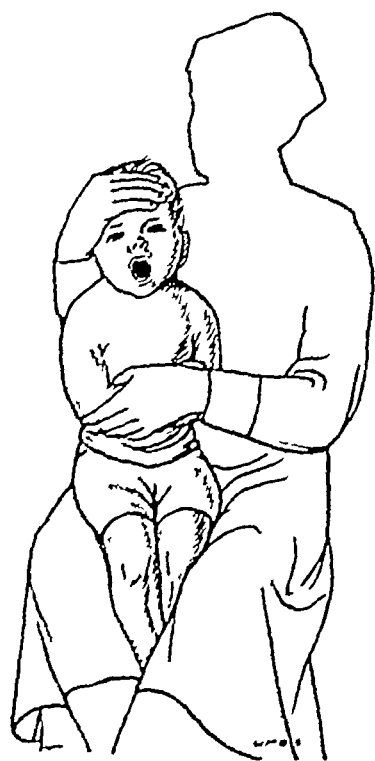


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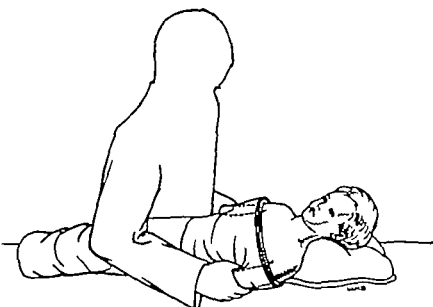


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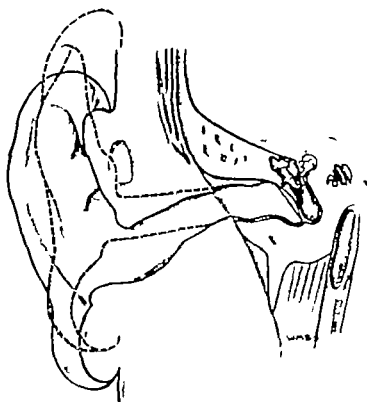


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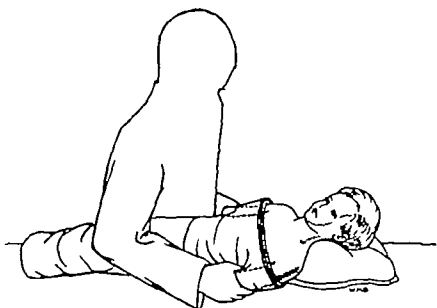


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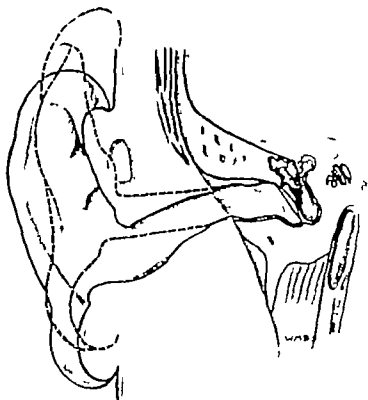


FIG 83 —SECTION OF THE RIGHT EAR TO ILLUSTRATE THE NECESSITY FOR PULLING THE EAR UPWARDS AND BACKWARDS DURING OTOSCOPY

best examined standing in front of the surgeon. A more satisfactory view of the throat can be obtained if the child breathes deeply through the mouth than if he be asked to say "Ah"

### EXAMINATION OF THE EAR

Small children are best examined lying down, wrapped in a blanket (Fig 82) Larger children stand in front of

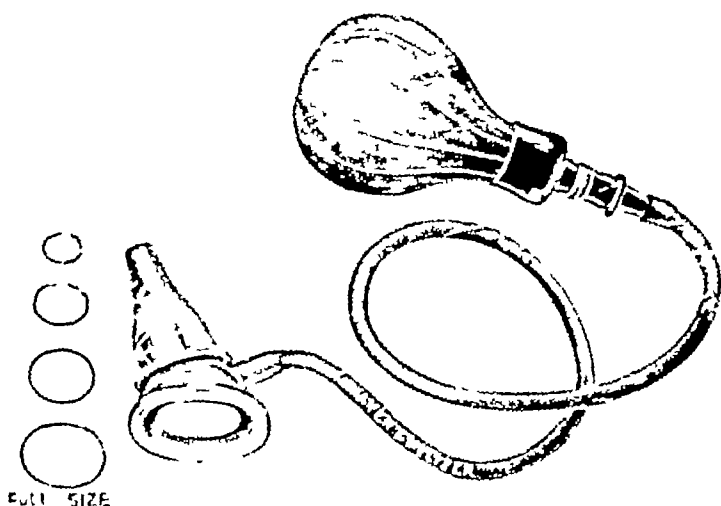


FIG 84 —PETERS' MODIFIED SIEGLE'S PNEUMATIC EAR SPECULUM

the surgeon, steadied by his knees. The ear must be pulled upward and backward in order to straighten the external auditory meatus before the speculum is inserted (Fig. 83) A Siegle's attachment is of great advantage (Fig. 84), as it makes possible the demonstration of small perforations and will often enable the surgeon to define the limits of an inflamed tympanic membrane where otherwise definition is impossible

### THE NOSE INJURIES

A fall or a blow on the nose is a common cause of injury in a child. There is often considerable epistaxis, and possibly fracture of the nasal bones or nasal process of the maxilla

um may be fractured or displaced or may develop  
oma The force site of impact and direction of the  
ermine the nature of the resultant injury

### FRACTURE

ing and bruising of the nose occur soon after the  
nd make the diagnosis of a fracture difficult If

there be any deformity a  
is certainly present De-  
of the nose can best be de-  
ted by standing behind the  
tilting his head backwards  
ing down along the nose  
n in this position will reveal  
ure line Clinical diagnosis  
reliable than radiography  
showing depressed fractures  
lower and anterior portion  
nasal bones (Fig 85) The  
ment is the essential factor  
e without displacement is of  
equence



FIG 85 — DIAGRAM OF A  
DEPRESSED FRACTURE  
OF THE TIP OF THE  
NASAL BONES

### Treatment

the child is seen before  
welling has developed any  
ment can be detected and

od position obtained by pressure with the fingers  
If there is much swelling evidence of a fracture will  
ed It is better therefore to delay any operation  
e swelling has subsided but not for more than a  
it after which time it may be impossible to mobilise  
ments. The nasal passages must be examined to  
ere is any obstruction to the airway in which case an  
must be made to rectify it

**Operation.**—The nose should be packed before operation with  $\frac{1}{2}$ -inch ribbon gauze wrung out in a mixture of equal parts of 10 per cent cocaine and 1/1,000 adrenalin, to reduce hæmorrhage and shrink the nasal mucosa. The child is then anæsthetised and a post-nasal sponge inserted. The nasal packing is now removed. The fragments are next mobilised and elevated. This can be done with special forceps Walsham's redressing forceps, or by strong-bladed

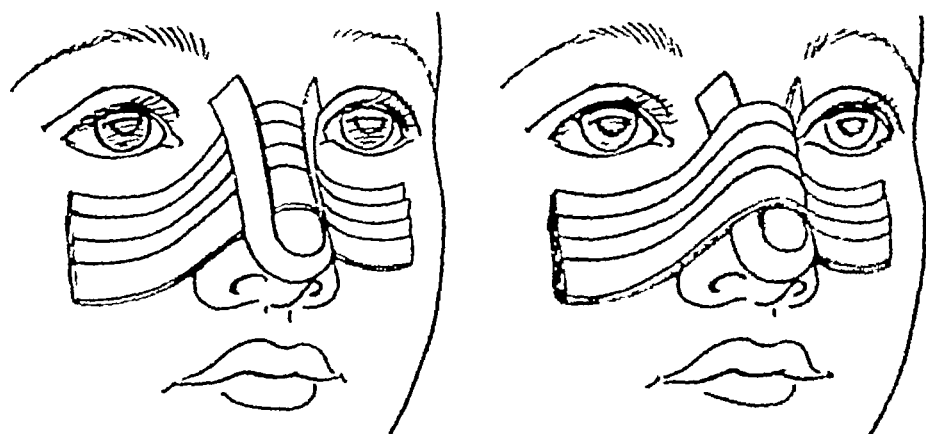


FIG. 86 —METHOD OF APPLYING THE STRAPPING SPLINT TO THE NOSE

Four pieces of half-inch strapping are laid transversely across the nose. One piece is now laid longitudinally across the other pieces and round the end of the nose and another four pieces are laid across this.

intestinal clamps. The blade to be applied to the skin must be covered with a piece of rubber tubing to prevent damage. The other blade is passed into the nose and the fractured bone firmly gripped and mobilised. The fragments are now put in position by the fingers. The nose is picked with gauze rubbed in No. 7 paraffin to prevent depression of the fragments during the application of the splint. A splint consisting of nine strips of  $\frac{1}{2}$ -inch strapping is now applied to the nose, as shown in Fig. 86. The nasal packing is removed and the splint left in position for from four days to one week.

## DISPLACEMENT AND FRACTURE OF THE SEPTUM

This injury is usually associated with fracture and displacement of the nasal bones and causes nasal obstruction of varying degree. It is detected by anterior rhinoscopy. It is frequently impossible to replace the nasal septum as it springs out of place immediately it is reduced. However an attempt should be made with Asch's septum forceps when the nasal fracture is reduced. The septal deformity can be cured by submucous resection of the septum but this operation should be delayed until the child is fully grown as if done during the period of growth it may lead to deformity of the nose.

## HÆMATOMA OF THE SEPTUM

This is caused by the extravasation of blood between the perichondrium and the cartilage and leads to bilateral nasal obstruction.

Anterior rhinoscopy reveals a red boggy swelling in both sides of the nose (Fig 87). This swelling is continuous with the septum and a probe can be passed between it and the lateral wall of the nose. When untreated a hæmatoma of the septum develops into a septal abscess and leads to destruction of the septal cartilage and deformity. The prognosis in these cases should be guarded as treatment does not always prevent the necrosis.



FIG 87—HÆMATOMA OF THE NASAL SEPTUM

### Treatment

The septum should be anaesthetised with equal parts of 10 per cent. cocaine and 1/1,000 adrenalin. A vertical incision is made in one side, and a piece of muco-perichondrium at the lower end is bitten out with punch forceps. The nose is then packed on both sides with gauze rubbed in No 7 paraffin in order to express the blood clot. This packing is left in for an hour or two. The child must be seen daily, the incision reopened, and the clot expressed until the septum no longer refills with fluid. It is desirable to keep the child in hospital, in which case the original packing can be left in place for twenty-four to forty-eight hours, and the period of treatment materially shortened thereby.

**Epistaxis.**—This usually stops in a short time, and the surgeon is rarely called upon to control it. Firstly, the effect of cold water or compresses on the forehead and bridge of the nose should be tried. When this fails the nose should be packed with gauze wrung out in 1/1,000 adrenalin, the packing being left in for one hour. The site of hæmorrhage in severe cases is usually the preturbinal area on the lateral wall of the nose, where the muco-periosteum may be torn by a fracture.

### FOREIGN BODIES IN THE NOSE

Foreign bodies in the nose may be either known or suspected. In the former group the child is presented by the parent, who states that a foreign body, a description of which is given, has been pushed up the nose by the child. This statement is usually true, and must be accepted until it is demonstrated otherwise.

For many years, vegetable and mineral matter, such as peas, beans, etc., have been known to become firmly fixed in the nose.

in the moisture of the nose they are liable to set up more irritation than mineral foreign bodies. Peas and beans have been frequently found to germinate in the nose. Mineral foreign bodies will remain unchanged inside the nose for a considerable time. For these reasons vegetable foreign bodies should be regarded as urgent cases whilst delay is permissible in cases of mineral foreign bodies.

The presence of a foreign body may be suspected by the

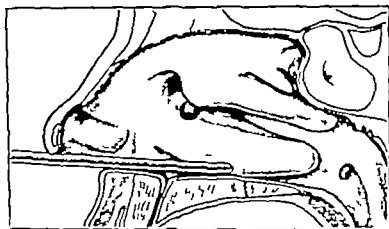


FIG 88 —A SMALL ROUND FOREIGN BODY LYING IN THE MIDDLE MEATUS OF THE RIGHT SIDE OF THE NOSE.

A grooved probe is being passed in order to remove it.

parent or the surgeon. If anterior rhinoscopy fails to reveal a foreign body it is as well to await events. In the case of a child suffering from chronic unilateral nasal discharge either purulent or muco-sanguineous and possibly unilateral dermatitis of the nasal vestibule there is strong presumptive evidence that there is a nasal foreign body and this diagnosis should be assumed until it is proved incorrect.

Foreign bodies in the nose lie in the middle meatus and in early cases can be seen by anterior rhinoscopy. In later cases there are swelling of the mucosa and a purulent nasal discharge which hide the foreign body until the mucosa is shrunk with cocaine and adrenalin and the discharge wiped away.



### Treatment

In older children examination and removal can be performed without a general anæsthetic. The nose should be sparingly sprayed with 2½ per cent cocaine. The foreign body may then be seen and removed with a bent or grooved probe, or with dressing forceps (Figs 88 and 89), or in the case of a rounded object a small pair of Luc's forceps. A suction apparatus is useful for cleaning the nose, and will sometimes remove a foreign body, especially if the latter be smooth. In younger children a general anæsthetic is neces-

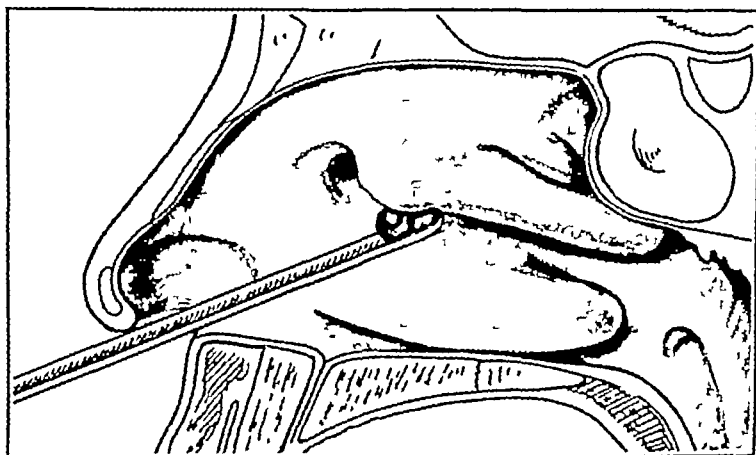


FIG 89—REMOVAL OF THE FOREIGN BODY WITH THE GROOVED PROBE

sary, for so delicate an operation is impossible in a struggling child.

The prognosis in these cases is good. The earlier the foreign body is removed, the less constitutional disturbance will the child suffer.

### EPISTAXIS

Nose bleeding is a symptom of many diseases, both local and general, and its significance varies with the cause.

#### General Causes

1. Prodromal symptom in an acute febrile disease—*e.g.*, smallpox, enteric fever, influenza.

- 2 Constitutional disease hæmophilia nephritis
- 3 High altitude
- 4 Chemical intoxication mercury and phosphorus poisoning

### *Local Causes*

- 1 Trauma (a) Bleeding from the nasal mucosa (b) associated with fracture of the base of the skull
- 2 Dilated vessels in Little's areas (Fig 90) the anterior portion of the cartilaginous septum This is the commonest cause of epistaxis and frequently occurs at or about puberty
- 3 Ulceration—e.g. rhinitis sicca This is frequently associated with deviation of the nasal septum.
- 4 Foreign body in the nose
- 5 Catarrhal inflammation
- 6 Nasal diphtheria
- 7 Simple new growth

### **Management of the Case**

In the great majority of cases of spontaneous epistaxis the hæmorrhage comes from Little's area and it should be treated on this assumption

A plug of cotton wool or gauze squeezed out in a mixture of equal parts of 10 per cent cocaine and 1/1000 adrenalin if available is placed in the nasal vestibule and preturbinal area of the affected side The nose is then pinched by the patient and held for five minutes in which time the bleeding will have ceased. To prevent recurrences of the hæmorrhage the bleeding points should be sealed with the galvano-cautery (Fig 90) The cocaine and adrenalin already put in will be sufficient anæsthesia for this to be done A chromic acid bead may be used as an alternative method in dealing with the young child who is frightened by the galvano-cautery

When the bleeding is not coming from Little's area and

cannot be controlled by ice packs applied to the nose and forehead, the nose must be packed under direct vision with  $\frac{1}{2}$ -inch ribbon gauze squeezed out in cocaine and adrenaline or some non-irritating antiseptic such as B I P P. Rarely the bleeding is so severe as to necessitate plugging the posterior nasal space to control it. This is only done in desperate cases because of the frequency with which it is followed by serious complications—*e.g.*, otitis media and mastoiditis (See p. 2). Bleeding following Adenoidectomy)

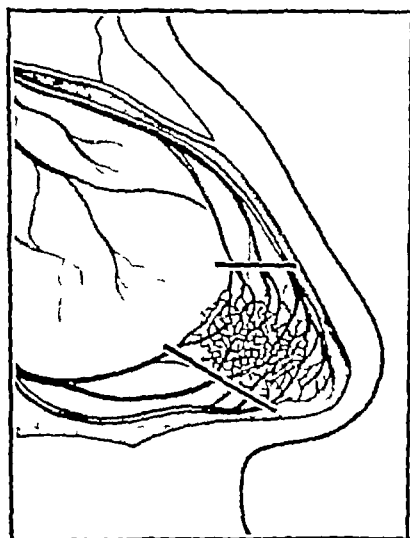


FIG 90 —THE BLOODVESSELS OF THE NASAL SEPTUM FORMING AN ANASTOMOSIS IN LITTLE'S AREA

The black lines show the positions for the application of the cautery

When bleeding is controlled the case must be investigated to determine the cause, which must then be treated. Resulting anaemia is treated by giving iron, if severe, by blood transfusion. In cases of hæmophilia a blood transfusion may be necessary during the hæmorrhage, if the latter cannot be controlled.

### ACUTE NASAL OBSTRUCTION

The nose may become obstructed as a result of injury, foreign bodies, acute infections, or vasomotor disturbance. Vasomotor disturbances are rare; injuries and foreign bodies have already been described. The acute infections may be primarily nasal or the nasal affection may be only part of a general disturbance—*e.g.*, prodromal symptoms of measles. The usual nasal infections are the common cold, membranous rhinitis, and diphtheria. The common cold is recognised by its course and clinical features. These are

general malaise with nasal obstruction and watery discharge which becomes mucoid and then muco-purulent finally clearing up in one to two weeks

Membranous rhinitis should be suspected of being diphtheria until culture of the nasal swabs fails to grow the Klebs-Löffler bacillus

Nasal diphtheria may be insidious in onset and the only indication a purulent or muco-sanguineous discharge with excoriation of the nasal vestibule All suspicious cases should be swabbed and if confirmed should be isolated and treated with serum

### THE ACCESSORY NASAL SINUSES

The increasing use of X rays in the diagnosis of sinusitis has shown it to be a much more common disease in childhood than was formerly believed

In the newborn baby no accessory nasal sinuses are present The maxillary antrum is represented at birth by a cleft in the lateral nasal wall This cleft deepens to become the antrum which is thus the first sinus to develop being recognisable as such at about the age of twelve months At birth the ethmoidal labyrinth is represented by a mass of cartilage the lateral mass of the ethmoid Cells are recognisable in the mass early in the first year The frontal sinus is late in development but may be recognised at the sixth year though it may not develop until the fifteenth to sixteenth year Therefore the sinuses most often affected in childhood are the antra and ethmoids though in cases where the frontal sinus develops early a fronto-ethmoiditis may be recognised

Acute nasal infections—e.g. the common cold and influenza—and bathing are the two common causes of sinusitis in children In every acute infection of the nose the sinuses are infected but usually the inflammation does not pass

beyond the stage of an acute catarrhal sinusitis. As it gives rise to no distinctive symptoms. If, however, inflammation progresses to an acute purulent sinusitis symptoms distinctive of acute inflammation of the affected sinus are produced.

#### MAXILLARY SINUSITIS

This is frequently bilateral, and is characterised by bilateral nasal discharge, general malaise, and possibly in the acute stages, tenderness over the antra. It is rarely recognised during the acute stages, however, and the child is brought for treatment because of a chronic nasal discharge. The nose is found to contain a muco-purulent secretion coming from under the middle turbinate, and a large mass of infected adenoids is almost invariably present. X-rays show opacity of the antra.

#### Treatment

A general anæsthetic should be given and the antrum punctured and washed out to confirm the diagnosis. If adenoids should then be removed. This will usually cure the sinusitis. If it fails, an intranasal antrostomy through the inferior meatus of the nose can be performed.

#### ACUTE ETHMOIDITIS

This condition is not uncommon in young children, and may appear at any age after the first year. The child gets an acute catarrhal infection of the nose, which does not resolve. The nose continues to be stuffy and the temperature remains raised. A muco-purulent discharge comes from one side of the nose, and there is tenderness on pressure over the ascending process of the superior maxilla and generally around the inner canthus of the eye. Examination of the nose will show pus coming from a swollen and red middle turbinate region, and X-rays will show opacity of the ethmoid cells and of the antrum on that side.

### Treatment

In the very young child very little can be done beyond putting the patient to bed and watching the progress of the disease. If the condition does not improve operation is necessary. A general anæsthetic is given and a post-nasal sponge is inserted. The anterior end of the middle turbinate is removed to relieve the congestion and establish drainage and an intranasal antrostomy is performed.

The condition is frequently complicated by the formation of an orbital abscess. That this can easily happen is shown in Fig. 91 where a fistula is shown in the orbital plate of the ethmoid leading to the production of an orbital abscess.

### ACUTE ETHMOIDITIS WITH AN ORBITAL ABSCESS

There is a hot red fluctuant swelling below and internal to the inner canthus of the eye. It is often mistaken for a dacryocystitis and is opened by an ophthalmologist who finds the pus issuing from a fistula in the orbital plate of the ethmoid and elevating the periosteum. There may or may not be a nasal discharge but there is usually a history of a recent nasal infection. The eye may be closed by the swelling of the eyelids and chemosis may be noticed. There is a coincident infection of the antrum in all cases.

### Treatment

An external operation is necessary. A small vertical incision  $\frac{1}{4}$  inch long is made internal to the inner canthus starting above on a level with the bridge of the nose and finishing below on a level with the lower border of the orbit. It is carried down to the bone and the periosteum of the orbital plate of the ethmoid and the nasal process of the maxilla is elevated. The ethmoid labyrinth is opened through the orbital plate and the cells removed. This involves removal of at least the anterior half of the

beyond the stage of an acute catarrhal sinusitis. As such it gives rise to no distinctive symptoms. If, however, the inflammation progresses to an acute purulent sinusitis, the symptoms distinctive of acute inflammation of the affected sinus are produced.

### MAXILLARY SINUSITIS

This is frequently bilateral, and is characterised by bilateral nasal discharge, general malaise, and possibly, in the acute stages, tenderness over the antra. It is rarely recognised during the acute stages, however, and the child is brought for treatment because of a chronic nasal discharge. The nose is found to contain a muco-purulent secretion coming from under the middle turbinate, and a large mass of infected adenoids is almost invariably present. X-rays show opacity of the antra.

### Treatment

A general anæsthetic should be given and the antra punctured and washed out to confirm the diagnosis. The adenoids should then be removed. This will usually cure the sinusitis. If it fails, an intranasal antrostomy through the inferior meatus of the nose can be performed.

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### Treatment

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### Treatment

An external operation is necessary. A small vertical incision  $\frac{1}{2}$  inch long is made internal to the inner canthus starting above on a level with the bridge of the nose and finishing below on a level with the lower border of the orbit. It is carried down to the bone and the periosteum of the orbital plate of the ethmoid and the nasal process of the maxilla is elevated. The ethmoid labyrinth is opened through the orbital plate and the cells removed. This involves removal of at least the anterior half of the



middle turbinate. A large opening is thus made into the nose. The skin incision is now sewn up with fine silkworm gut, this being permissible as the abscess is drained into the nose. An intranasal antrostomy is now performed. The eye must be washed out daily with boracic lotion during the time it is kept covered, and the stitches should be taken out on the fourth or fifth day. The wound may break down a

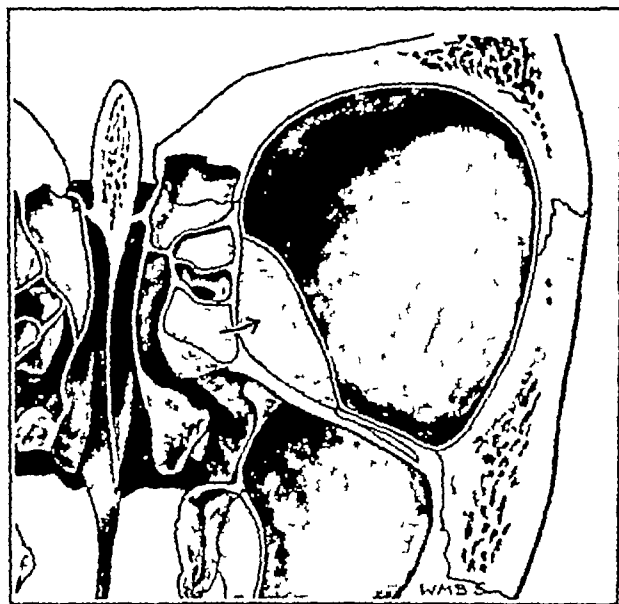


FIG 91 —DIAGRAMMATIC SECTION THROUGH THE ETHMOID LABYRINTH, THE ORBIT, THE MAXILLARY ANTRUM AND THE NOSE

One of the ethmoid cells is full of pus, which has perforated the orbital plate of the ethmoid and given rise to an orbital abscess

when the child grows up it can be made invisible by judicious powdering

little, but it will usually heal without further operative treatment. Intranasal after-treatment is difficult in small children, but fortunately very little is necessary. The nasal vestibule should be kept clear of crusts and blood clots by swabbing with moist cotton-wool, and probably no more need be done. The scar is very unobtrusive, and

#### ACUTE FRONTO-ETHMOIDITIS

This occurs in older children. It perforates the bone later than the acute ethmoiditis of early childhood. The child complains of unilateral frontal headache and nasal discharge, and there may be œdema of the eyelids. The tem-

perature is raised and examination will show tenderness over the floor of the frontal sinus and a muco-purulent secretion in the nose. This will appear from under the anterior end of the middle turbinate. Opacity, and possibly a fluid level in the frontal sinus and antrum will be seen in the X ray photographs.

### Treatment

Severe complications are probably more often caused than averted by early operative treatment and the treatment is therefore conservative. The patient is put to bed. Packs of cotton wool wrung out in 10 per cent cocaine and 1/1 000 adrenalin are inserted into the middle meatus of the nose and left there for twenty minutes twice daily with the object of shrinking the nasal mucosa and promoting drainage. The antrum is punctured and washed out and this is repeated as often as seems necessary—usually on alternate days. Steam inhalations with menthol and benzoin are used four hourly. If a subperiosteal abscess appears it must be drained by external operation but this wound should be left open for drainage and the operation completed at a later date when the acute phase of the disease is over.

The complications which may occur are spreading osteomyelitis of the frontal bone, extradural abscess, meningitis, frontal lobe abscess and cavernous sinus thrombosis.

## THE THROAT PHARYNX

### INJURIES

The fauces and oro-pharynx may be injured by puncture wounds such as may be sustained by falling on to a pencil or similar object held in the mouth. The torn mucosa is kept clean by mouth washes and if necessary by painting with 10 per cent protargol in water. Complications are rare.

**FOREIGN BODIES**

Except at the cricopharyngeal sphincter it is only sharp foreign bodies which lodge in the pharynx—for example, fish-bones, toothbrush bristles, fragments of chicken-bone. The commoner places for these to stick are at the tonsil, the base of the tongue, and the posterior aspect of the larynx. In the first two positions the foreign body can be seen by depressing the tongue, or with certainty by means of a laryngeal mirror. It can usually be grasped and removed by a pair of forceps. In older children this can be made possible by spraying the throat with a little 2½ per cent cocaine, which must, however, be used sparingly until it is clear that the child has no idiosyncrasy to it. In small children a general anæsthetic will often be necessary. When the foreign body is stuck in the laryngo-pharynx, it will be impossible to see and remove without a direct laryngoscope and special forceps. Therefore these children should be sent to a hospital where the special instruments are available.

**ACUTE INFLAMMATIONS****ACUTE TONSILLITIS**

This is not a surgical emergency, but some description must be given so that it can be differentiated from a peritonsillar and retropharyngeal abscess. The patient complains of sore throat and discomfort on swallowing. The temperature is usually high and the child very ill. The tongue is furred and the tonsils are symmetrically enlarged and reddened. There may be several discrete patches of exudate on the tonsils, but the fauces are clear. The patches may be wiped off easily and do not leave a raw surface underneath, thus distinguishing the condition from faucial diphtheria. The cervical glands are enlarged and tender. There is sometimes such gross enlargement of the tonsils that dyspnoea results, and very rarely a tracheotomy is necessary to relieve this (see p. 247).

### Treatment

The patient is put to bed and a purgative administered. A high fluid intake with glucose should be maintained and alkalis given. In small children no local treatment is indicated. In larger children the tonsils may be painted three times daily with 10 per cent protargol. After the patient has recovered the question of tonsillectomy must be considered.

### PERITONSILLAR ABSCESS

This is rare though cases have been reported in children of one year and under. The patient has an acute tonsillitis which improves and apparently recovers. After a few days the symptoms rapidly recur the temperature rises and a peritonsillar abscess develops. There is cervical glandular enlargement more marked on the affected side. On examination of the throat the fauces are seen to be asymmetrical. The affected tonsil is displaced towards the mid line by the swelling of the abscess outside it and the soft palate is bulged forward on the affected side. The palate is a plum red colour and in the later stages pus may be seen through the mucosa where the abscess is going to point. The uvula is swollen and œdematous and is seen clinging to the affected tonsil. Swallowing is very difficult and in the later stages saliva cannot be swallowed and dribbles from the patient's mouth.

This condition must be distinguished from a retro-pharyngeal abscess in which the swelling is behind the tonsil which is pushed and rotated forward. The soft palate is not swollen, but is pushed forward and examination will show that the swelling is behind the tonsil and not external to it.

### Treatment

As soon as it is thought that pus is present the peritonsillar abscess must be opened. The criteria of the

presence of pus are the appearance and the feel of the swelling. If the latter is very pronounced and a paler area can be detected, then pus is near to the surface. The peritonsillar inflammation is of rubbery consistency, and when pus forms it begins to soften. Fluctuation can never be detected, as it is impossible to palpate the swelling with more than one finger. The danger of opening the abscess

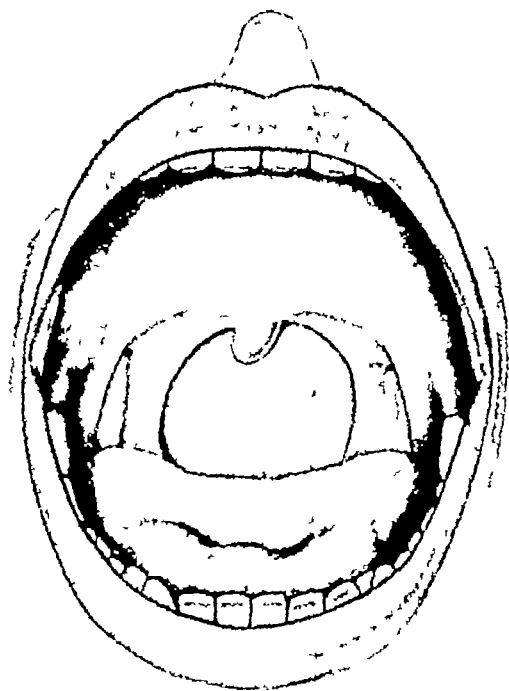


FIG. 92.—NORMAL PHARYNX TO COMPARE WITH FIG. 93

is that blood and pus may be aspirated into the bronchi. It is therefore dangerous to give a general anæsthetic, and the abscess should be opened without anæsthesia of any sort. The pain is only momentary, and relief follows so quickly that it may be done without frightening the child unduly. The child is wrapped in a blanket and firmly held by a nurse, a gag is inserted and the point for opening the abscess is determined. Sinus forceps are now pushed through the mucosa into the abscess,

opened and withdrawn. The child now leans forward and the gag is removed. Hot mouth-washes are used immediately. There is no fear of excessive hæmorrhage, and any bleeding that occurs can be ignored.

The site of opening is carefully planned. It must be remembered that the pus is above and external to the tonsil, and is displacing it inward. The opening should be made in the tonsil, and not in the pharynx. The opening should be made in the tonsil, and not in the pharynx.

the point at which a horizontal line drawn from the base of the uvula crosses a vertical line drawn from the last molar tooth (Fig 93)

In the case of the small child the after treatment consists in swabbing out the mouth but in older children hot mouth washes of carbolic (glycerine of phenol 10 minims to ounce) or potassium chlorate (10 grains to the ounce) should be given hourly

The question of tonsillectomy should be considered in children at six weeks

#### RETROPHARYNGEAL ABSCESS

A retropharyngeal abscess may be one of two varieties. It may be due to an abscess in one of the deep cervical glands or to an abscess arising from a caries of the vertebral spine and extending in front of the

vertebral bodies and therefore behind the pharynx. It is important to distinguish between these varieties as the treatment of each differs completely

An *acute retropharyngeal abscess* is due to suppurative inflammation of a deep cervical gland which lies between the prevertebral and the pharyngeal fascia. These two layers of fascia are separated in the mid line and therefore an acute retro-

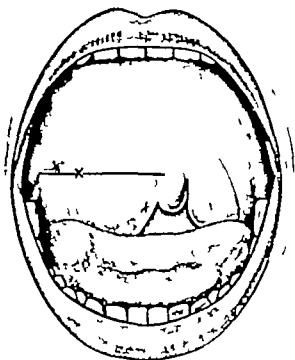


FIG 93—PERITONSILLAR ABSCESS WITH POINT FOR INCISION SHOWN BY THE CROSS

(See text.)

pharyngeal abscess does not cross the mid-line—a most important fact. It occurs usually in small children towards the end of the first year of life. Sucking becomes difficult and the baby cries a great deal, and there is much dribbling of saliva from the mouth. The cervical glands on one side of the neck are enlarged, and the temperature is raised. On examination a soft red swelling is seen in the posterior wall of the oro-pharynx, pushing the tonsil and soft palate forwards. The swelling is soft, and gives the impression of fluid content to the examining finger. The swelling does not cross the mid-line.

The abscess should be incised from the pharynx, under light general anæsthesia. A gag is inserted and the swelling defined. When the child is nearly recovered from the initial anæsthesia, a sponge is inserted into the pharynx, and the abscess incised and the pus expressed with the sponge. The child is then turned on its face and the sponge removed. Sucking is resumed soon after incision, and recovery is usually smooth and uninterrupted.

*Retropharyngeal abscess secondary to cervical caries* has a different history. The child is older and usually has some stiffness of the neck, though this is not constant. The discomfort in swallowing comes on gradually, and it is weeks before any serious difficulty in swallowing occurs. The child is not acutely ill, and the temperature is only slightly raised. On examination there is a swelling in the posterior part of the oro-pharynx. This swelling is situated in the mid-line, is soft, and only slightly tender. Jarring the cervical vertebræ may cause pain. X-rays of the cervical spine should be taken, but may be negative, even when cervical caries is present. This variety of abscess should never be opened into the pharynx.

## HÆMORRHAGE FOLLOWING OPERATION FOR REMOVAL OF TONSILS AND ADENOIDS

Hæmorrhage in children is a more serious matter than in adults and its treatment therefore brooks no delay. Fortunately it is rare as a complication of tonsillectomy. The few cases of serious hæmorrhage which occur are nearly always due to the presence of a blood disease and hence any previous history of bleeding should be investigated before operation is undertaken. By this means most of the misfortunes can be avoided. Hæmorrhage following tonsillectomy may be immediate reactionary or remote.

*Immediate* hæmorrhage may be controlled by holding a sponge in the tonsillar fossa for a few moments. Cold water applied to the forehead is also useful. Only rarely is it necessary to apply a ligature.

*Reactionary* hæmorrhage occurs usually in the first twenty-four hours after operation but it may be delayed for forty-eight hours. It is caused by the blood pressure rising in the post-operative period and the increasing activity of the child loosening the clot in a vessel. Children collapse very suddenly from loss of blood and therefore ligature of the bleeding vessel should not be unduly delayed. Removal of the blood clot from the fossa and holding a sponge there will sometimes control the hæmorrhage but a recently tonsillectomised child will not tolerate this and it is therefore usually impossible. As a rule the patient should be given a sedative, ice packs should be applied to the forehead and a quarter hourly pulse chart started. If the bleeding does not stop within an hour or two or if the pulse rate starts increasing rapidly the patient should be anæsthetised. The bleeding point which is nearly always to be found at the lingual end of the fossa is identified and ligatured. Very rarely there is a general ooze from the tonsillar bed. In these cases a gauze plug wrung out in B I P P should



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## HEMORRHAGE FOLLOWING OPERATION FOR REMOVAL OF TONSILS AND ADENOIDS

Hæmorrhage in children is a more serious matter than adults and its treatment therefore brooks no delay. Fortunately it is rare as a complication of tonsillectomy. A few cases of serious hæmorrhage which occur are nearly always due to the presence of a blood disease and hence a previous history of bleeding should be investigated before operation is undertaken. By this means most of the misfortunes can be avoided. Hæmorrhage following tonsillectomy may be immediate, reactionary or remote. Immediate hæmorrhage may be controlled by holding a sponge in the tonsillar fossa for a few moments. Cold water applied to the forehead is also useful. Only rarely is it necessary to apply a ligature.

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be placed in the fossa and the pillars of the fauces sewn over it. It should be left *in situ* for forty-eight hours.

*Secondary hæmorrhage* is a very rare complication of tonsillectomy occurring from the fifth to the tenth day. If slight, it can usually be controlled by putting the child to bed for two days, but when more severe the mouth may be washed out with hot lotion and a swab soaked in hydrogen peroxide held in the fossa. An injection of hæmoplastin is sometimes useful. Very rarely it may be necessary to give the child an anæsthetic and ligate the bleeding point or points.

### **Bleeding following Adenoidectomy**

Rarely the hæmorrhage after removal of the tonsils and adenoids is seen to come not from the tonsillar fossæ but from the nasopharynx, and may give rise to much trouble before it is finally controlled. If conservative means fail, the child should be anæsthetised and a Boyle-Davis gag inserted. The tonsillar fossæ are found to be dry, but blood wells up from the nasopharynx. This is sponged out and the nasopharynx palpated with the finger. It is sometimes found that a tag of adenoid tissue has been left hanging from the posterior pharyngeal wall. This should be removed with an adenoid curette, and when the nasopharynx is clear of adenoid tissue a swab should be held in it for a minute or two and the nasopharynx finally painted with Whitehead's varnish. In the majority of cases these measures will suffice to stop the bleeding. If, however, the bleeding continues, the nasopharynx must be plugged.

**Method of Plugging the Nasopharynx.**—A strip of gauze is rubbed in iodoform and glycerine or B.I.P.P. and knotted into a mass about the size of the nasopharynx. A tape is tied firmly round this, leaving two long ends. A soft rubber nasal catheter is passed down the nose, picked up in the pharynx, and one end pulled out through the mouth, the

tape tied on to it and the catheter withdrawn through the nose. There is thus one end of the tape passing into the mouth into the nasopharynx and out through the nose. This tape is pulled upon to manœuvre the plug into the nasopharynx and then pulled tight and tied on to a piece of gauze too big to be pulled through the nostril keeping the nasopharyngeal plug firmly in position and preventing it from slipping back into the pharynx or larynx. The other end of the tape coming through the mouth is left fairly loose and is strapped to the cheek to be used when the nasopharyngeal plug is removed. This plug will be found to control the hæmorrhage. There is a considerable risk of inducing acute otitis media and mastoiditis by the presence of the plug and the relatives should be warned of this possibility. When for twenty four hours there has been no further hæmorrhage the plug can be removed. If there has been some oozing the plug should remain for forty-eight hours in spite of the added risk of otitis. To remove the plug the end of the tape coming through the nose is cut short and a gag inserted. A finger is passed along the end coming through the mouth until it reaches the posterior pharyngeal wall and the plug removed by pulling the tape downwards out of the nasopharynx. The child should be kept quietly in bed for several days in order to avoid the risk of further hæmorrhage.

Rarely in cases of epistaxis the nasopharynx must be plugged and when necessary it should be done by this method.

## LARYNX, TRACHEA, AND BRONCHI

### FOREIGN BODIES

Foreign bodies in the air passages rarely lodge in the larynx. They fall as low as their size will permit usually into the main bronchus or lower lobe bronchus.

A large foreign body will occasionally become impacted in the upper laryngeal aperture. Unless the doctor is close at hand when this accident occurs there is no time for him to be sent for. The foreign body leads to complete respiratory obstruction. It may be dislodged by the finger, which can reach the laryngeal aperture in a child. If this fails, a laryngotomy must be done through the crico-thyroid membrane with whatever instruments are available at the moment. The foreign body can easily be removed when a direct laryngoscope and forceps are available.

Flat foreign bodies and small pointed ones may lodge in the larynx. The inhalation of the foreign body leads to a bout of coughing, which rapidly settles down, and leaves the child with a hoarse voice, and perhaps stridor and dyspnoea. A flat foreign body always sticks with the flat surface lying in the antero-posterior plane, so that an antero-posterior X-ray will only show its edge. This is in contrast to a foreign body sticking in the lower larynx or upper œsophagus, when it always occupies a transverse plane.

A foreign body in the larynx must be removed without undue delay, but it is a mistake to attempt the removal without adequate instruments. A direct laryngoscope and suitable endoscopic forceps are essential, and the patient should be sent to a centre where these are available.

**In the Trachea and Bronchi.**—Foreign bodies inhaled into the trachea and bronchi give rise to an attack of coughing which settles in a few minutes. After this there is a complete absence of symptoms for a varying period. A vegetable foreign body will produce symptoms in a comparatively short time. In a day or two the child will develop a severe bronchitis, which increases the difficulties and dangers of removal. A mineral foreign body, on the other hand, may be in the lung for weeks before producing any symptoms.

**Vegetable Foreign Bodies.**—The common bodies met are

peas, beans and nuts. They usually lodge in the lower lobe bronchus. When they are inhaled there is a fit of coughing and then a latent period occurs. The bronchi dilate during inspiration and contract during expiration. The foreign body will therefore let air pass it during inspiration and will prevent air escaping from the lung during expiration. Thus an X-ray photograph during forced expiration will show the obstructed lobe to be relatively translucent. The presence of a foreign body is thus determined and its situation fixed. It should be removed during the latent period and therefore the child should be sent at once to a centre where expert bronchoscopic treatment is available.

**Mineral Foreign Bodies**—The onset is identical with that of a vegetable foreign body. The latent period is however much longer and it may be years before its presence causes trouble. This is no reason for undue delay in its removal but it is important to realise that there is no need for unseemly haste and attempts to remove the foreign body without adequate instruments. The common foreign bodies are teeth, beads, pins and screws and can usually be seen with X-rays and the position determined thereby. The prognosis is good if the removal is in the hands of a skilled bronchoscopist and the object not of a variety excessively difficult to remove—e.g. an open safety pin. If left in the lung these foreign bodies eventually cause the formation of a lung abscess.

### TRACHEOTOMY

An emergency tracheotomy is only rarely performed in children for conditions other than diphtheria. Occasionally acute oedema of the glottis is seen and very rarely an emergency arises in cases of papilloma of the larynx.

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There are two factors to be considered in doing a tracheo-

tomy firstly, saving the patient's life by short-circuiting the obstruction, and secondly, performing this in such a way that unwanted sequelæ are avoided. The greater the urgency of the case, the more prominence is given to the first consideration. The operation described below is the one of choice, and no harm is done by a tracheotomy tube remaining in the position described. A higher tracheotomy may be done in emergency operation performed under bad conditions, but it must be regarded purely as a temporary measure, and must be replaced by a low tracheotomy at the first opportunity.

The patient is anæsthetised and is placed flat on the table with a thin sandbag under his shoulders and no pillow. The head is extended and held straight in the mid-line by the anæsthetist. The extension of the head brings the trachea nearer the surface. A mid-line incision is made from the cricoid above to the upper border of the manubrium sterni below. Skin vessels are clipped. The infrahyoid muscles are defined and separated in the middle line. The isthmus of the thyroid is now encountered and is pulled upwards. If any difficulty is met, the isthmus may be divided between artery forceps and the two halves separated. The trachea is now identified. The tracheotomy should leave the first and second rings of the trachea intact in all cases, and is best made through the fourth and fifth rings. The cricoid is easily identified and the rings counted from it. There is considerable movement of the larynx and trachea owing to the obstructed respiration. When the trachea is defined, it is steadied by the cricoid hook, which is plunged through the anterior wall between the cricoid and the first ring. The fourth ring is now identified and a piece of cartilage is excised, leaving a window in the trachea equal in diameter to that of the tracheotomy tube. The advantage of making this window is that if the tube slips out of the trachea the obstruction can at once be relieved.

by the nurse holding the skin edges apart until the surgeon arrives to replace the tube. When no window is cut the obstruction is not relieved until the tube is replaced. The tracheotomy tube is now inserted. A Durham's tube will be found the most convenient. Bleeding points are ligatured. The wound is partly sewn up but room is left round the tube for a little light packing with B I P P gauze. The inner tube must be kept clean and free of obstruction.

When time presses the operation can be done with local injection of novocaine 1 per cent. or without any anæsthesia. In these cases it is permissible to do the tracheotomy through the first or second ring of the trachea. They are nearer the surface than the lower rings and the operation can be done in one or two minutes. This must however be regarded as a temporary operation as a tracheotomy tube in this position is very liable to lead to stenosis of the larynx.

## ŒSOPHAGUS

### FOREIGN BODIES

Foreign bodies in the œsophagus are fairly common during childhood. Halfpennies, whistles, nuts and safety-pins are all seen but coins are much the commonest.

After swallowing the coin the child has a feeling of discomfort in the chest. There may be retching. There is difficulty in swallowing except for fluids. There will be no clinical signs except perhaps that some froth can be seen in the pyriform fossæ by indirect laryngoscopy. X rays will show the coin to be lodged in the upper œsophagus lying transversely so that an antero-posterior photograph shows it full face. It appears to be prevented by the first rib from passing further and lies opposite the first and second bodies of the dorsal vertebræ. Œsophagoscopy should be performed and the foreign body removed.

Attempts at removal with the coin catcher or probang are entirely unjustifiable, being not only inefficient but very dangerous. On œsophagoscopy the coin is found to be just below the cricopharyngeal sphincter, and can easily be removed with crocodile forceps.

Other foreign bodies become lodged at one of three positions—the cricopharyngeal sphincter, the point where the left bronchus crosses the œsophagus, and the lower end. They should be removed under direct vision with an œsophagoscope.

Sharp foreign bodies may cause serious complications—para-œsophageal abscess, cervical cellulitis, and mediastinitis. Great care must therefore be exercised in removing them in order to avoid perforating the œsophagus and causing one of these complications. Stenosis of the œsophagus may be a late result of para-œsophageal inflammation secondary to a foreign body.

## THE EAR

### INJURIES TO THE EAR AND AURICULAR APPENDAGES

The auricle may be torn or may develop a hæmatoma as a result of a blow. It shows great powers of healing, and even the most extensive tears and cuts should therefore be cleaned and sewn up, for the majority will heal satisfactorily.

A hæmatoma is caused by a blow on the ear, and when untreated develops into the scarred, deformed ear of a pugilist—the “cauliflower” ear. Treatment is directed towards preventing this deformity. The hæmatoma should be incised and the blood clot expressed, the incision being left open to prevent the hæmatoma reforming.

### EXTERNAL AUDITORY MEATUS : FOREIGN BODIES

Foreign bodies are sometimes pushed into the external auditory meatus by children. The parent may bring the

child because of a known foreign body or because the child complains of earache or possibly of bleeding from the ear. On examination of the ear the presence of a foreign body is soon determined. Any doubt is quickly overcome by the use of a probe.

### Removal of the Foreign Body

Syringing is contra indicated unless the surgeon knows that he is dealing with a small foreign body which can easily escape from the meatus and that it will not swell in the presence of water. Removal is a delicate procedure and it is essential in order to avoid the risk of damaging the tympanic membrane to have a still patient. Therefore if the child is small and apprehensive a general anæsthetic should be given. A hooked probe is probably the most useful instrument in removing foreign bodies which are usually beads, nuts or peas. The probe is passed along the meatus on the flat and when the hook has passed beyond the foreign body the probe is rotated so that the hook projects into the lumen of the meatus. The probe and foreign body can then be withdrawn together. Forceps may often be used but with a rounded object there is a tendency to squeeze it deeper into the meatus which is too narrow to allow of a good grip. Living foreign bodies—*e.g.* maggots and insects—are best removed by filling the external auditory meatus with paraffin to kill the invaders and then syringing out the dead bodies.

### TYMPANIC MEMBRANE

This is sometimes ruptured by a blow on the ear. A sudden severe pain is felt and there will be some bleeding from the ear which however may be so slight as to pass unnoticed. Deafness of the middle ear type may be present and can be detected by hearing tests. Otoscopy will reveal a rupture in the membrane with a little blood clot round the

**EARACHE**

Since earache is a common complaint in childhood, an attempt will be made to classify the causes so that the differential diagnosis may be simplified. Earache may be referred pain or may have a local cause.

**Referred Earache.**—In these cases the external auditory meatus and tympanic membrane are normal in appearance, there is no discharge, and no deafness can be detected. The common causes of referred earache are dental caries, alveolar abscess, acute tonsillar inflammations, disorders in the temporo-mandibular joint, and mumps, one of which will usually be revealed on examination. There is one other condition which might be included under this heading—viz, facial herpes. The patient develops facial paralysis and earache. Examination of the ear reveals no abnormality, but in two to three days a herpetic rash appears on the external auditory meatus and concha.

**Earache due to Local Causes.**—These may be either impacted wax, foreign bodies or inflammation in the external auditory meatus, or acute otitis media and acute mastoiditis. Deafness can be detected in all cases except in those in which the external auditory meatus only is affected, and in which there is no obstruction.

**AFFECTIONS OF THE EXTERNAL AUDITORY MEATUS**

**Otitis Externa Hæmorrhagica.**—Sometimes called influenza otitis media, this disease usually begins during an attack of influenza, but it may arise without previous illness. There is sudden and very severe earache, with distinct tenderness over the mastoid process, most marked over the antrum and tip. There may also be pre-auricular tenderness. The temperature is considerably raised, usually up to 102° to 103° F. Examination shows a diffuse inflammation. Scattered over this area and over the external surface of the tympanic membrane are dark blue hæmorrhages.

rhagic blebs. The condition gives rise to considerable confusion as no landmarks can be distinguished and it is easy to believe that one of the blebs is a normal tympanic membrane or a bulging drum especially if examined with indifferent illumination. The use of the Siegle's speculum allows the limits of the membrane to be defined and it is then seen that the membrane moves well carrying the blebs with it. Tests will show no loss of hearing. The important feature of this disease is that it frequently develops into an acute otitis media—one of a very virulent type which develops rapidly into an acute mastoiditis. When acute otitis media develops the drum bulges but this is difficult of recognition. The most reliable and valuable sign is loss of hearing. The infecting organism is usually a hæmolytic streptococcus.

There is no operative treatment for this condition unless complications develop. The child must be put to bed and calomel (1 gr.) is given followed by a dose of salts the next morning. Otalgin or 1/4 000 perchloride of mercury in glycerine drops should be instilled into the meatus. Hot fomentations or a hot water bottle wrapped in flannel applied to the ear help to relieve the pain. A close watch is kept on the otitic condition so that a myringotomy may be performed early if otitis media develops.

**Furunculosis.**—The child complains of severe earache which is usually of rather gradual onset and preceded by irritation in the ear. He is not generally ill but there may be a history of boils or septic spots elsewhere in the body. The temperature is usually under 100° F. There is tenderness round the ear the point of maximum tenderness being the pre auricular lymphatic glands. Movement of the pinna causes pain. Otoscopy will show one or more inflamed areas situated as a rule near the outer end of the meatus. These points have the characteristics of boils elsewhere in the body. The pain is greater than the severity



of the local lesion would suggest, because the skin is closely bound down to the periosteum and perichondrium, and a small lesion causes much tension and therefore much pain.

There are two factors to consider in the treatment firstly, the relief of pain and hastening of the resolution; and secondly, the prevention of recurrences. Injections of colossal manganese hasten resolution, often aborting an attack and preventing further attacks. It is given intramuscularly in three doses of  $\frac{1}{2}$  c c., 1 c c., and  $1\frac{1}{2}$  c c. on the first, third, and fifth days. Hot fomentations are helpful, and ear drops of ung. hyd. nit. dil. 1 part, ol. amygdal. 3 parts, should be instilled into the ear twice daily. Incision of the furuncle may rarely be indicated.

**Dermatitis or Eczema.**—This condition arises spontaneously, or as the result of an otorrhœa. There is redness, tenderness, and swelling of the external auditory meatus. The pre-auricular and mastoid lymph glands are enlarged. There may be a watery discharge from the meatus, and the patient complains of discomfort and irritation rather than pain. The temperature is only slightly, if at all, raised. When this condition is superimposed on a discharging ear, the question arises as to whether an acute mastoiditis is developing or whether it is a simple dermatitis. The differential points are that the temperature is only slightly raised, the mastoid tenderness is superficial and not deep, the pre-auricular glands are enlarged, the meatus is uniformly swollen and œdematous, and not only the deep postero-superior angle as would be the case in acute mastoiditis.

The ear is syringed daily with normal saline. Wicks of cotton-wool soaked in 10 per cent. ichthyol in glycerine are inserted into the meatus and left there for twenty-four hours. The patient's general health must receive attention. In children it is usual to give cod-liver oil and malt. It is sometimes a long while before the condition is completely cured.

## ACUTE OTITIS MEDIA

Acute inflammation of the middle ear is nearly always caused by an infection ascending the Eustachian tube from the nasopharynx. Occasionally however the infection is blood borne or may reach the middle ear through a hole in the tympanic membrane.

The patient complains of earache the temperature is raised and there is a history of recent catarrhal affection of the upper air passages. The otoscopic appearance varies with the stage of the disease. In some cases the progress is rapid in others slow but each case passes through all these stages. The first change is injection and engorgement of the vessels round the periphery of the tympanic membrane and of the vessel running along the handle of the malleus. Next the tympanic membrane loses its lustre and hence the light reflex is lost. The tympanic membrane now begins to bulge commencing in the postero-superior quadrant and spreading clockwise round the membrane until the whole membrane is convex towards the examining eye except for the umbo where there is a dimple caused by attachment of the tip of the handle of the malleus. At this stage is present the classical picture of the bulging drum. The latter is red and fleshy having lost its translucent appearance and bulges towards the observer with a dimple at the centre. It is often difficult to determine where the meatus ends and the drum begins. The Siegle's speculum helps in deciding and though the intra tympanic pressure prevents much movement of the drum it yet allows sufficient movement to differentiate it from the meatal wall. The next stage is perforation. The membrane gives way usually in the antero-inferior quadrant and allows the discharge of the intra tympanic collection of pus. To arrive at a diagnosis at this stage it is essential to mop the pus out of the meatus with pledgets of cotton wool. Even when

the meatus is cleaned it may be impossible to see the perforation until it is exposed by sucking pus through it with a Siegle's speculum. The perforation may or may not provide adequate drainage. In the former case the earache will cease, the temperature fall, and the drum appear flat, in the latter case the earache will continue and the drum will still bulge in spite of the drainage.

Very soon after the onset of the earache, and perhaps preceding it, deafness will appear. This is seldom noticed in children, but can be detected by tests in all but the very young. It is the last symptom to disappear on resolution of the disease. Tinnitus may also be noticed.

Tenderness over the mastoid antrum and tip are often present until the tympanic membrane is incised or ruptures. It then disappears, but if acute mastoiditis develops it reappears later. During the early stages before the otorrhœa, mastoid tenderness is a sign of acute otitis media and not of acute mastoiditis.

### Treatment

In the early stages before there is fluid in the middle ear—*i.e.*, before the membrane is bulging—an attempt is made to abort the attack. The child is put to bed, a purgative is given, and heat applied to the ear to relieve the pain. In older children steam inhalations with menthol, 2 gr., tinct. benzoin co., 1 oz., are given four-hourly to relieve the nasopharyngeal congestion and to clear the Eustachian obstruction. A careful watch is kept on the middle ear, for myringotomy (paracentesis auris) must be performed as soon as bulging of the tympanic membrane develops.

**Myringotomy** is performed under general anæsthesia. Before the anæsthetic is administered the external auditory meatus is syringed so that the surgeon can be sure that his vision will be unimpeded by cerumen or other debris. The child is anæsthetised, the ear swabbed with spirit and the

meatus filled with spirit which is then mopped out. This is to prevent secondary infection of the middle ear by organisms introduced from the external auditory meatus. The tympanic membrane is now defined and the incision made in the posterior portion of the membrane starting from below and cutting upwards. In this way the surgeon can look along the upper border of the myringotomy knife and see where he is cutting. The incision starts below in

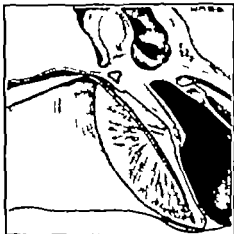


FIG 94—THE POSTERIOR HALF OF THE RIGHT MEATUS AND MIDDLE EAR WITH THE KNIFE PLUNGED THROUGH THE TYMPANIC MEMBRANE TO BEGIN THE INCISION FOR MYRINGOTOMY

FIG 95—COMPLETION OF THE MYRINGOTOMY

the postero-inferior quadrant and runs upward midway between the handle of the malleus and the posterior border of the tympanic membrane. It is carried up to the roof of the meatus (Figs 94, 95 and 96). Pus and blood will be seen issuing from the middle ear. The meatus should not be plugged with cotton wool but filled with spirit and a dry dressing applied. Myringotomy should also be done in cases of spontaneous perforation where drainage is not adequate.

**After-Treatment.**—The ear should be syringed daily with

saline; 1/2,000 perchloride of mercury in glycerine drops are very satisfactory for instillation after syringing. They are painless, bland, and antiseptic, and do not discolour nor distort the tympanic membrane or meatus to make observation difficult. Myringotomy should relieve the earache almost at once, and for the following few days a purulent otorrhœa is to be expected. The discharge of pus usually begins to lessen in four to five days, and in fourteen days

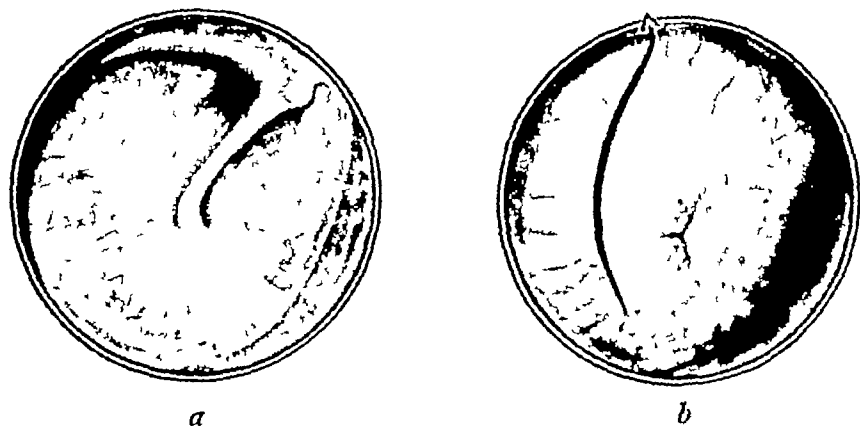


FIG 96 —(a) NORMAL RIGHT TYMPANIC MEMBRANE AS SEEN THROUGH AN AURAL SPECULUM (b) RIGHT ACUTE OTITIS MEDIA WITH BULGING TYMPANIC MEMBRANE, SHOWING THE INCISION FOR MYRINGOTOMY.

the tympanic membrane should be healed and normal in appearance, except perhaps for some peripheral injection and lack of lustre. The hearing should return to normal within three to four weeks. The nose, nasopharynx, and throat should now be examined, and enlarged septic tonsils and adenoids removed.

In cases in whom drainage is still

## ACUTE MASTOIDITIS

This condition is a sequel to an attack of acute otitis media. There are two recognisable clinical varieties—the ordinary acute mastoiditis and the septicæmic type.

The patient has acute otitis media and the tympanic membrane ruptures or is incised and the temperature falls but never quite settles. The earache disappears and there is a profuse continuous aural discharge. Usually in about ten days the temperature rises again to the region of 100° F earache reappears and the discharge increases in amount. On examination there is generalised tenderness over the mastoid antrum and there may be some periosteal thickening which will make the ridges on the mastoid process less distinct than those on the normal side. There may be definite œdema over the mastoid process or even a subperiosteal abscess in which case a fluctuant swelling will be present pushing the ear forward and outward. Examination of the meatus reveals a discharge coming from the inflamed middle ear. The deep part of the meatus is narrowed by a sagging down of the postero-superior wall which appears red and inflamed. This sagging is a most important sign of acute mastoid infection and is indeed often the only definite sign that can be elicited. Its presence is due to the proximity of the mastoid antrum to the meatal wall. Hearing is greatly reduced the tests showing a well marked middle-ear deafness.

*The septicæmic type* varies from the former chiefly in relation to the time factor. The period which elapses between the first appearance of symptoms and the development of definite signs of acute mastoiditis may be only a matter of three to four days. The child is very ill with a high temperature (103 to 104° F) and intense earache. Within a few hours the drum is bulging and myringotomy releases a profuse sero-sanguineous discharge. The tem

perature remains high, and on the third day there is very well marked mastoid tenderness, and the deep meatus is completely occluded by the sagging of the postero-superior meatal wall. Operation must be performed at once, as serious complications develop at a rate comparable with the speed of development of the acute mastoiditis. Diagnosis in these cases is often difficult, as a similar condition sometimes arises as the result of otitis externa hæmorrhagica when the hæmorrhagic blebs obscure the view and apparently narrow the deep meatus. If any doubt exists in otitis externa hæmorrhagica as to whether an otitis media has supervened, a myringotomy should be performed.

### **Treatment**

The treatment of acute mastoiditis is operative. The operation performed is known variously as Schwartz's operation, the classical mastoid operation, cortical mastoid operation, and mastoid antrostomy. The objects of the operation are to open and drain the mastoid antrum and all the mastoid air cells, to provide posterior drainage for the middle ear, and to leave the cavity in the condition most favourable for sound healing to occur.

**Preparation.**—The hair is cut and the scalp shaved for about 3 inches round the ear, and this area is then swabbed with spirit and a sterile dressing applied. Atropine ( $\frac{1}{16}$  to  $\frac{1}{8}$  gr) is administered half an hour before operation, and the other usual preoperative preparations made.

**Operation.**—The child is anaesthetised and lies flat on his back on the operating table. A sandbag is placed under the head, which is rotated to lie on the healthy ear and kept stable in this position. The dressing is now removed, the operation area again swabbed with spirit and isolated by means of sterile towels, the ear is once more examined and the diagnosis confirmed. Myringotomy is performed if the drainage of the middle ear appears to be inadequate.

The ear is held forward and a curved incision made parallel to and  $\frac{1}{4}$  inch behind the groove between the ear and the mastoid process with its upper limit about  $\frac{1}{4}$  inch above the upper border of the meatus and its lower limit at the tip of the mastoid process (Fig 97) The incision is carried right down to the bone throughout its whole length There is a danger in making the incision in infants for the mastoid process is undeveloped and therefore the stylo-mastoid foramen opens on to the external surface of the skull If therefore the incision is carried too far forward and too far down the facial nerve may be cut in the extracranial part of its course

At the lower angle of the wound a vessel will spurt and should be clipped with artery forceps The periosteum is now elevated with a rougine over the whole mastoid process The bleeding is controlled by picking up the edges of the

cut periosteum with artery forceps and pulling them over the skin edges after which a Mollison's self retaining retractor is inserted and the posterior border of the bony meatus defined The surgeon must not separate the periosteum of the posterior meatal wall nor must he take down the posterior meatal wall as both these manœuvres are likely to give rise to stenosis of the external auditory meatus.

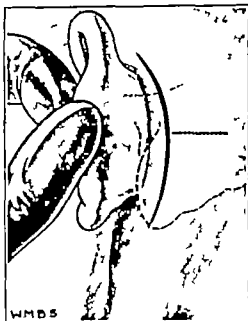


FIG 97—THE ORDINARY INCISION FOR THE ACUTE MASTOID OPERATION

The dotted line is the posterior extension of this incision made in cases where the original incision does not give sufficient exposure to deal with posterior cells



The upper limit of the meatus and the superior meatal spine of Henle must now be identified (Fig 98). The level of the upper border of the meatus corresponds with the level of the dura of the middle fossa and the roof of the mastoid antrum. Just behind the upper border of the

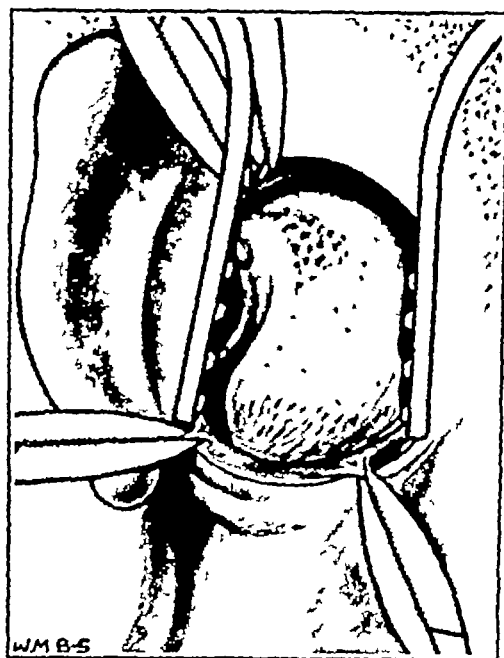


FIG 98—THE EXPOSURE OF THE MASTOID PROCESS OBTAINED AFTER ELEVATION OF THE PERIOSTEUM AND ADJUSTMENT OF THE RETRACTOR

Note the definition of the upper and posterior borders of the meatus and the superior meatal spine of Henle

meatus an area of bone is identified by the many small vascular foramina seen on its surface. The mastoid antrum is deep to this area in a direction parallel to the posterior border of the meatus—that is to say, inward and slightly forward. The depth of the antrum varies with the age of the child. In infants it is three to four millimetres from the surface, and in adults two to three centimetres.

The mastoid antrum is the surgeon's first objective. Its upper limit is fixed by the superior border of the meatus and its anterior limit by the posterior meatal wall. The surgeon must bear in mind the

variability of the relation of the lateral sinus to the mastoid process. There is sometimes only a very narrow space between the posterior meatal wall and the anterior part of the lateral sinus.

With the use of a gouge the surgeon removes bone in the direction of the antrum until the latter is exposed. This

is usually easy in acute mastoiditis in children as once the outer shell of the bone is removed the diseased air cells can be broken down with a spoon and the antrum entered. The antrum is recognised as a large cavity in the right place and by the one definite feature—the aditus leading from its anterior wall. Sometimes all these features are rather obscured and definite identification has to be delayed until later in the operation when part of the outer wall of the aditus has been removed and the bony external semicircular canal exposed and identified. The level of the dura of the middle fossa is definitely fixed by the level of the roof of the antrum. Bone is therefore removed to bring the upper border of the cavity flush with the roof of the antrum. Working from the antrum backward and downward all the cells are opened and their walls removed. This will lead the surgeon backward to the lateral sinus. Here he may be stopped by the thin layer of dense bone covering the sinus or the sinus may be exposed and is recognised by its blue shining appearance. Mastoid cells may extend backward superficial to the sinus. When this is so the surgeon should have no hesitation in making another incision at right angles to the first in order to obtain adequate exposure (see Fig 97). The cells towards the tip must now be opened. Working in this direction it is essential to remember the position of the facial nerve which follows a vertical course in a line with the posterior meatal wall deep to the internal wall of the antrum and aditus. When all the cells have been exposed special attention must be paid to the angle between the middle fossa and the lateral sinus and the direction of the zygoma for there may be present in these two situations infected cells which may easily be missed. A small chip of bone is now removed from the outer wall of the aditus to increase the posterior drainage of the middle ear.

The resulting cavity should now be lined throughout by smooth dense bone and there should be no air cells opening

from it. It is bounded above by the roof of the antrum, and possibly some exposed dura of the middle fossa; behind by the lateral sinus, which has probably been exposed; in front by the posterior meatal wall and the aditus above (Fig 99).

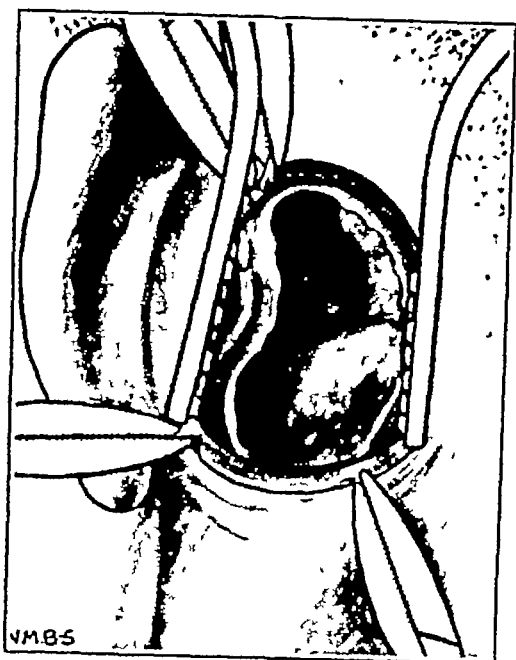


FIG 99.—THE MASTOID CAVITY READY FOR PLUGGING AT THE COMPLETION OF THE OPERATION

Note the position of the antrum in relation to the bony meatal wall, the shelving posterior and inferior borders of the cavity, the absence of cells in the lining of the cavity and the bulge of the lateral sinus in the posterior part of the cavity

The cavity is syringed with hydrogen peroxide to remove any fragments of bone, and the retractor and artery forceps are removed. If a posterior extension of the incision has been made it is sewn up, together with the upper half of the main incision, using fine silkworm gut. The cavity is now lightly packed with 1-inch ribbon gauze impregnated with iodoform as follows: finely ground iodoform is suspended in spirit, the gauze is wrung out in saline, and iodoform from the suspension is put on it with a spoon or spatula and rubbed in with the hands.

This dressing seems to keep

sweet better than the oily emulsions of iodoform or bismuth, and can be safely left in for four days. A heavy dressing of gauze and cotton-wool is now bandaged on, preferably with a crêpe bandage.

**After-Treatment.**—In the ordinary type of acute mastoiditis the temperature falls after operation and remains normal from about the fourth day. The chief complaint

is stiffness of the neck due to interference with the upper end of the sternomastoid muscle. In the septicæmic type the temperature often rises after operation and remains high for three or four days before settling by lysis to reach normal on about the seventh or tenth day.

On the first day the top dressing is replaced by a lighter one and on the fourth a general anæsthetic is given and the plugging removed. It is replaced by another plug of iodoform gauze packed fairly tightly into the antrum and lightly into the rest of the cavity and is changed on alternate days. The stitches are removed on the sixth day. The post auricular wound will take a month to six weeks to heal.

After the operation the surgeon's chief consideration is the middle ear. The aural discharge will continue for about a week but in ten days or so the ear should be healed and dry and the hearing improving. The aditus gets closed off posteriorly in about a fortnight and when this has taken place the middle ear is independent of the post auricular wound and the hearing should rapidly improve. If the middle ear is not dry in ten days the ear should be syringed daily with saline and spirit drops instilled after syringing. The hearing should return to normal provided that the middle ear becomes dry in a reasonably short space of time after operation.

#### COMPLICATIONS OF ACUTE MASTOIDITIS

**Extradural Abscess** — This is rarely diagnosed before operation. The only symptom is constant temporal head ache but this is by no means always present. The abscess is usually situated over the lateral sinus but may be external to the dura of the middle fossa. On exposure of the sinus pus escapes and the sinus is seen to be covered with granulations its blue shiny appearance converted to a shaggy dark red wall. This is known as a *perisinus abscess*.

The abscess must be widely exposed until healthy sinus

is seen all round the granulating area, so that no locus remains undrained. This manœuvre may involve extensive removal of bone. The case is subsequently treated in the same way as an uncomplicated mastoid.

**Lateral Sinus Thrombosis.**—When a patient with acute otitis media, and more certainly a patient with an acute flare-up of a chronic otitis media, has a rigor, there is strong presumptive evidence that thrombosis of the lateral sinus has occurred. Operation should not be delayed. The mastoid is opened and the lateral sinus is widely exposed. A perisinus abscess is found. The sinus is then incised, and if thrombosed it is seen to be filled either with clot or pus. In neither case will there be a gush of blood as from a healthy sinus. The mastoid wound is covered and left for the moment. An incision in the neck is made along the anterior border of the sternomastoid, which is retracted backwards to expose the carotid sheath. The internal jugular vein, collapsed and much smaller than was expected, is identified and traced upwards to its junction with the common facial vein. If it is not thrombosed down to this level, it is tied and cut between two ligatures above the junction with the common facial vein. If it is thrombosed below this, it is tied below the lower limit of the thrombus. The wound in the neck is left open and lightly packed. A dressing is put on and attention turned once more to the mastoid wound. The incision is carried backwards along the course of the lateral sinus for about 2 inches. This may be extended later if necessary. Bone is now removed until healthy sinus is exposed, and this is incised backwards until blood gushes out. The bleeding is controlled by digital pressure until a small plug of iodoform gauze is inserted between the bone and the sinus. The thrombosed sinus and the wound are lightly packed with iodoform gauze and left open to heal by granulation. The prognosis is bad, and a stormy convalescence may be expected. Pyæmic infec-

tion of joints is common during the post-operative period but occasionally an uninterrupted recovery is made

**Meningitis**—This sometimes complicates acute mastoiditis. The signs and symptoms are headache vomiting and head retraction and Kernig's sign may be present. Lumbar puncture will show the fluid to be under pressure and containing many polymorphonuclear leucocytes. The mastoid should be opened and drained and lumbar puncture repeated duly. The prognosis is very grave when organisms are found in the cerebrospinal fluid.

**Brain Abscess.**—This is a rare complication the few cases that occur being complications of a chronic otorrhœa. The patient complains of headache and vomiting without nausea. Papilloedema may be present. Neurological signs vary with site of abscess. Common sites are the temporo-sphenoidal lobe and the cerebellum but localising signs may be conspicuous by their absence. If an abscess is suspected the mastoid should be opened the dura widely exposed and incised. The brain is then explored and if the abscess is found a large drainage tube is inserted. Prognosis is bad.

**Petrositis**—The mastoid air cells may extend forward and inward to the apex of the petrous bone. Rarely these cells become infected and give rise to an abscess in that position. A child with acute mastoiditis may complain of double vision and examination reveals a sixth nerve paralysis. This is an indication for an immediate mastoid operation. The paralysis usually clears up and the post-operative period is uneventful. Occasionally however the temperature remains high the ear continues to discharge and pain develops in the distribution of the fifth nerve and radiography reveals destruction of bone at the petrous apex. Drainage of the abscess must be undertaken as soon as the diagnosis is made. The condition is so rare an occurrence and the operation presents so many difficulties that a detailed description of it would be out of place in this book.



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